PROCEEDINGS

OF THE

ASSOCIATION OF OFFICIAL SEED ANALYSTS

OF

NORTH AMERICA

1937

IMPERIAL MYCOLOGICAL
17 MAY 1938
INSTITUTE

Twenty-Ninth Annual Meeting
Washington, D. C., August 23–26, 1937

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EDITED BY PUBLICATIONS COMMITTEE
W. O. WHITCOMB
C. W. LEGGATT
M. T. MUNN

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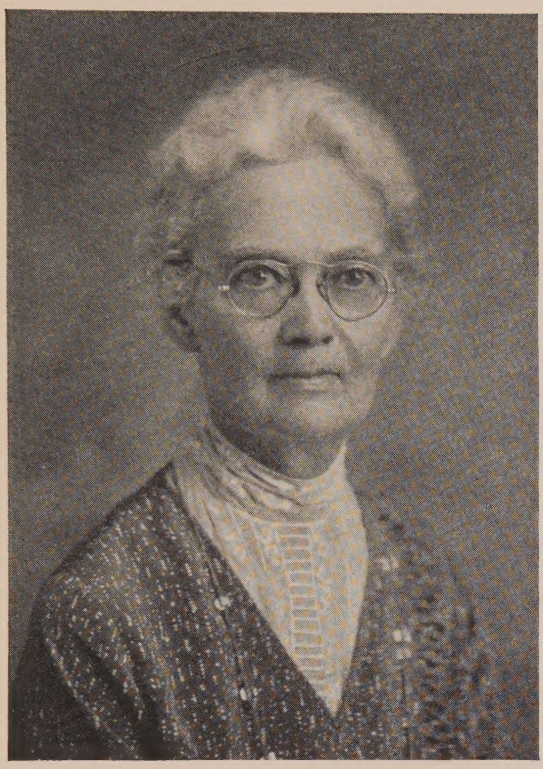

Miss Charlotte M. King

The death of Miss Charlotte M. King on May 26, 1937, marked the passing of one of the pioneers in seed analytical work and one of its gifted artists. During her 46 years of service in Iowa State College, she served as botanical artist, assistant botanist, seed analyst, and research assistant professor. As early as 1891, she was associated with Dr. L. H. Pammel in studies of impurities in clover seed which was offered for sale and in 1906 she assisted in the establishment of the seed testing laboratory of the Botany Department. The Iowa seed law was enacted the same year.

Miss King was born in Lakeville, Mass. in 1864. At an early age, she moved with her parents to Des Moines, Iowa, where she completed her schooling and taught for several years. In 1889, she entered Iowa State College as a special student and became interested in the botanical work which was to fit her for her lifework.

OFFICERS AND COMMITTEES

1936–1937

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W. A. Davidson ..... *Secretary-Treasurer*
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M. T. Munn
W. H. Wright

Handbook

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C. W. LEGGATT

Certified Label Plan

A. L. STONE, *Chairman*
W. O. WHITCOMB
G. P. STEINBAUER

REGISTER

Official Analysts

Alabama, L. N. Allen.

Arkansas, J. E. Casey.

Canada, Montreal, J. A. Pepin.

Canada, Ottawa, C. W. Leggatt, G. A. Elliott, G. A. Scott.

Canada, Sackville, Andrew Hope.

Canada, Vancouver, Cecil Tapp.

Canada, Winnipeg, A. C. Heise.

Colorado, Anna M. Lute.

Connecticut, Olcott King.

Delaware, Royden L. Hammond.

Illinois, L. A. Moore, J. E. Barnes, Walter F. Cameron.

Indiana, Regina B. Schulte.

Iowa, R. H. Porter, E. O. Brown.

Kansas, J. W. Zahnley.

Maine, G. P. Steinbauer.

Maryland, F. S. Holmes, Ellen P. Emack, Olive M. Kelk.

Massachusetts, F. A. McLaughlin, Jessie Anderson.

Michigan, C. A. Stahl.

Minnesota, Ruby U. Crouley.

Missouri, Clara Fuhr.

Montana, W. O. Whitcomb.

Nebraska, Raymond Kinch.

New Hampshire, Bessie G. Sanborn.

New York, M. T. Munn, W. F. Crosier, S. F. Patrick, Dolores Weimer.

North Carolina, Susie D. Allen, Elizabeth M. Eby, Mildred B. Henry, J. W. Woodside.

North Dakota, Edith C. Higgins.

Ohio, C. N. McIntyre.

Oklahoma, W. J. Lackey.

Pennsylvania, Mary C. Mowry.

South Carolina, F. H. Corley, Helen W. Umont

U. S. Dept. of Agriculture, E. Brown, E. H. Toole, Alice M. Anderson, W. A. Davidson, Emma F. Sirrine, Albina F. Musil, Harriet Cull, Alma E. Eggleston, Vivian Kearns Toole, Frankie-Jo M. Torpy, Nellie B. Wilkinson, Louisa Ames, G. E. Stancliff, Robert C. Hess.

Virginia, Lawrence T. Berry, Jennie S. Jones, Carroll M. Bass, Dorcas Hooker, Lucy W. Morton, Ada G. McFarland.

West Virginia, Marvin H. Snyder.

Wisconsin, A. L. Stone.

Commercial Analysts

Mary Akers, Ross Seed Co., Louisville, Kentucky.

Louise C. Baker, Barrow-Agee Laboratories, Memphis, Tennessee.

J. E. Benedict, Jr., Commercial Seed Laboratory, Washington, D. C.

Grace H. Blakeborough, Farm Service Inc., Lansing, Michigan.

Bertha DeHam, Peppard Seed Co., Kansas City, Missouri.

Ruth E. Evans, Whitney-Eckstein Seed Co., Buffalo, New York.

Alma Everard, Vaughn Seed Co., Chicago, Illinois.

Helen Horn, Indiana Farm Cooperative, Indianapolis, Indiana.

Marian Kellogg, Allied Seed Co., Fort Wayne, Indiana.

Clara Mangelsdorf, Ed. F. Mangelsdorf & Bro., St. Louis, Missouri.

W. W. OPPEL, Courteen Seed Co., Milwaukee, Wisconsin.

HELEN PEEBLES, J. Charles McCullough Seed Co., Cincinnati, Ohio.

V. L. PEMBLE, Assoc. Seed Growers Laboratory, Milford, Connecticut.

WALTER C. PFAENDER, Albert Dickinson Co., Chicago, Illinois.

KERCHEVAL E. SMITH, Wm. G. Scarlett & Co., Baltimore, Maryland.

VERNE SNELL, Rudy-Patrick Seed Co., Kansas City, Missouri.

MACY L. SPRACHER, Northrup-King & Co., Minneapolis, Minnesota.

HARRY E. VEGIARD, Crosman Seed Co., East Rochester, New York.

OTHER VISITORS

HENRY A. WALLACE, Secretary of Agriculture.

FREDERICK D. RICHEY, Chief, Bureau of Plant Industry, U.S.D.A.

F. H. HILLMAN, Washington, D. C. (U.S.D.A.)

R. H. HASKELL, Washington, D. C. (U.S.D.A.)

MRS. G. A. ELLIOTT, Ottawa, Canada.

MARY ELLIOTT, Ottawa, Canada.

MARGARET ELLIOTT, Ottawa, Canada.

ELEANOR BIRKHOLM, Lansing, Michigan.

MARGARET SEPANEK, Lansing, Michigan.

L. M. KING, Minneapolis, Minnesota (Northrup-King & Co.).

MRS. J. W. ZAHNLEY, Manhattan, Kansas.

MRS. W. A. DAVIDSON, Cheverly, Maryland.

H. H. MILLER, Bloomington, Illinois (Funk Bros. Seed Co.).

LLOYD E. ARNOLD, Bloomington, Illinois (Funk Bros. Seed Co.).

A. H. MANGELSDORF, St. Louis, Missouri (Ed F. Mangelsdorf & Bro.).

ROBERT E. TAPP, Wilmington, North Carolina.

KATIE KIRKPATRICK, Stillwater, Oklahoma (Soil Conservation Service).

L. D. EAGLES, Washington, D. C. (Soil Conservation Service).

W. A. WHEELER, Washington, D. C. (U.S.D.A.—B.A.E.)

G. C. EDLER, *Washington*, D. C. (U.S.D.A.—B.A.E.)

LENA B. WALLACE, Washington, D. C. (U.S.D.A.—B.P.I.)

JEAN M. VOELKLE, Washington, D.C. (U.S.D.A.—B.P.I.)

LOUISE CLOUSE, Washington, D. C. (U.S.D.A.—B.P.I.)

WALDO C. HICKS, JR., Washington, D. C. (U.S.D.A.—B.P.I.)

MARGARET PENFIELD, Washington, D. C. (U.S.D.A.—B.P.I.)

THELMA HENDRIXSON, Washington, D. C. (U.S.D.A.—B.P.I.)

ROBERT W. LEUKEL, Washington, D. C. (U.S.D.A.)

A. G. JOHNSON, Washington, D. C. (U.S.D.A.)

WELCOMING ADDRESS

HONORABLE HENRY A. WALLACE

Secretary of Agriculture

It is appropriate that the Secretary of Agriculture should welcome a group of this sort and should place at your disposal any facilities which may be of help to this organization. I would like to say, personally, that I have had sufficient observation of the seed business for many years to have a very great respect for the function of a good seed business in the United States.

I suppose not one person in a thousand appreciates as completely as he or she should the importance of the best kind of seeds, the importance of the difference between good seeds and bad seeds.

You, of course, appreciate that but you haven't driven home the appreciation of the difference in the public mind to the extent that you should. The seed trade as a whole has not driven home the difference to the extent that it should. There is not only the matter of having seeds free from weed seeds, which is so important with the clover and grass seed and also some small grain seeds, but there is the matter of strong germination of the seeds, trueness to variety, and of seeds coming from the localities which will result in freedom from winter killing and in adaptability with respect to season.

Those things, those various points with respect to seeds can be known, and you know that they can be known. Most farmers when they buy seeds are not as certain as they might be with respect to these various points. They do not know that the seeds are free from certain weeds; do not know that they have a certain germination; do not know that they are the right varieties or were grown in the right places.

They can know, of course, but unfortunately most farmers, even though the seeds carry the labels giving this information, do not know, do not have enough curiosity to know. They depend on other things. That has changed enormously in the past fifteen years and the reason why it has changed, I suppose, is due to this organization, and I want to say that I am happy that you are meeting here in Washington with our Bureau of Plant Industry people and I hope they will do everything they can to make your meeting a success and your future endeavors fruitful.

MINUTES
TWENTY-NINTH ANNUAL MEETING, WASHINGTON, D. C.
AUGUST 23–26, 1937

The 29th Annual Meeting of the Association of Official Seed Analysts of North America was held at the U. S. Department of Agriculture, Washington, D. C., on August 23 to 26, 1937.

The attendance totaled 113, of which 67 were representatives of official laboratories, 18 were members of the Commercial Analysts' Association, and 28 were visitors. There were 34 official laboratories represented.

On the morning of August 24, a breakfast was held in honor of Mr. F. H. Hillman and Mrs. Hillman. Mr. E. Brown responded for the U. S. Department of Agriculture, Mr. H. H. Miller for the seed trade, Miss Macy L. Spracher for the commercial analysts, Miss Anna M. Lute for the States, Dr. C. W. Leggatt for Canada, and Mr. L. H. Dewey, formerly of the U. S. Department of Agriculture, as a boyhood chum and schoolmate. As a token of the high esteem in which Mr. Hillman is held, and in appreciation of the broad and lasting contribution which he has made to the science of seed testing, a desk set was presented by Mr. G. A. Elliott in behalf of the Association.

The following actions were taken at the business session:

1. It was moved and carried that the Association of Official Seed Analysts at this 29th annual meeting adopt the proposed Uniform State Vegetable Seed Law before it for consideration and recommend its passage in the several states.
2. The proposed "Rules and Recommendations for Testing Seeds" were adopted by the Association as its official rules. (These will be considered to become effective July 1, 1938.)
3. The matter of how the rules shall be published was left to the discretion of the Executive Committee.
4. The Executive Committee authorized the Secretary-Treasurer to sell copies of the 23rd, 24th, 25th, and 26th Proceedings which will be published under one cover, at $3.00 per copy.
5. The chairman of the history committee was instructed to prepare the accumulated material for publication and obtain estimates as to cost of publication.
6. It was moved and carried that the Treasurer of the Association of Official Seed Analysts of North America be bonded for $2,000.00, the cost of such bond to be paid by the Association.
7. It was moved and carried that the proposed constitution be returned to the committee for further consideration, and that it be published in the *News Letter* not later than December and the suggestions to the committee be considered and the final form of the constitution be published in the *News Letter* not later than April.
8. The recommendations numbered 1, 2, and 5, made by W. L. Goss in his Presidential address in 1935, were referred to the Rules Committee; Recommendation No. 4 was referred to the Legislative Committee; and No. 3 was tabled indefinitely. (See Proceedings 28th meeting, page 25.)
9. A. L. Stone was chosen to represent the Association in the Seed Council of North America.

10. Since it was the opinion of the committee on the Certified Label Plan that this subject should receive further study by a larger committee, the report was referred back to such new committee.
11. The committee consisting of E. Brown, M. T. Munn, and W. H. Wright, which had formerly acted as a committee on arrangements for the meeting of the International Seed Testing Association in this country, was designated as the committee on arrangements for the meeeting in 1940.
12. In regard to seeds in interstate commerce, it was resolved, as being the considered recommendation of the Association, that:

    (a) There be compulsory labeling of all seeds shipped in interstate commerce for seed purposes.
    (b) There be labeling of packet vegetable seeds on the basis of a standard of germination.
    (c) Weed seeds deemed to be noxious should be determined by the soil and climatic conditions of the state into which the seed is shipped for presumed sale to the consumer.
    (d) The seller should be responsible for the germination of the seed on the date of delivery to the purchaser regardless of the date of test stated on the label.
    (e) A system of seed control providing for licensing of analysts in the employ of seedsmen to issue what may be considered official certificates is not in the public interest.
    (f) The detailed inspection of seeds in interstate commerce should be effected by cooperation between the U. S. Department of Agriculture and the inspection staffs employed by the several states.
    (g) The Secretary-Treasurer of this Association so advise the Secretary of the U. S. Department of Agriculture and such other persons and organizations as may be in interest.
13. Whereas the Association of Official Seed Analysts recognizes the efforts made by the International Crop Improvement Association in crop improvement and the reduction of misrepresentations in seed, and recognizes the importance of certified seed in this program, it was resolved that in common purpose the Association proposes its members bend every effort to assist in obtaining laws that will define "certified seed" and declare restrictions of the use of the term; foster varietal identification of seed; discourage the purchase and planting of weed seeds; and by other means assist in crop improvement.
14. It was resolved that the Association recommend to all laboratories that in the future they recognize the significance of the plant disease carrying possibilities of seed stocks, and that in providing for the personnel of their staff, and more particularly in arranging report blanks or forms, provision be made to care for the reporting upon the sanitary condition or health of the seed stock being tested, along with the other factors now being regularly determined.
15. It was resolved that the Association notes with interest the efforts now being made by the International Seed Testing Association to fully consider the necessity and practicability of changing the International Rules for Seed Testing so that but one uniform method of making the purity analysis will be used. To that end, our association pledges its good offices and the hearty cooperation of all committees concerned to study and consider the fundamental principles involved, and to bring about this desirable situation

of uniformity. The Association confirms its previous resolution that a purity analysis method such as exemplified in our Rules has been found most practical and leads to greater uniformity of results.

16. It was resolved that the Association fully approves of the resolution adopted by the International Seed Testing Association to the effect that there be urged a more general use of the International Analysis Certificate accompanying shipments of seed stocks in international commerce; that a germination test percentage should not be reported or quoted upon seed stocks without its accompanying purity analysis percentage; and that the germination percentage quoted express as faithfully as possible the actual plant-producing ability of the seed stock.
17. It was resolved that the Association of Official Seed Analysts at this 29th annual meeting held in Washington, D. C., wishes to express its thanks and appreciation to:
    (a) The United States Department of Agriculture for the use of the splendid auditorium and other facilities.
    (b) To Henry A. Wallace, Secretary of Agriculture, and F. D. Richey, Chief, Bureau of Plant Industry, for their cordial welcome and their interest in the work of our Association.
    (c) To the personnel of the Seed Laboratory of the United States Department of Agriculture for the fine arrangements of all details for our meetings and our social events.
    (d) To our officers and committees for the splendid program and the manner in which our work and meetings have been carried out.
    (e) To Dr. and Mrs. Toole and to Mr. and Mrs. Torpy for the flowers which graced our banquet tables.
    (f) To Mrs. E. H. Pitcher for the courtesy of the delightful facilities of the Columbia Country Club.
    (g) To Miss Viola Randolph, Mr. Henry A. Magnuson, and Mr. Victor H. Neal for the delightful entertainment which added so much to our annual dinner.
    (h) To Dr. Charles Sando and Dr. J. Russell Fessenden for a display of a new and interesting method of preserving plants, seeds, insects, and other valuable specimens.
    (i) To Dr. C. W. Leggatt for able editing of the *News Letter.*

The secretary was instructed to send a letter of greetings from the Association to Mr. K. Dorph-Petersen, President of the International Seed Testing Congress.

The 30th annual meeting of the Association of Official Seed Analysts will be held in Guelph, Ontario. The newly elected officers are Emma F. Sirrine, Washington, D. C., President; L. N. Allen, Montgomery, Alabama, Vice-President; W. A. Davidson, Washington, D. C., Secretary-Treasurer.

The appointment of the chairmen of the following standing committees was announced: Research Committee, R. H. Porter, Ames, Iowa; Legislative Committee, C. N. McIntyre, Columbus, Ohio; Public Service Committee, F. A. McLaughlin, Amherst, Massachusetts, and Cooperative Service Committee, J. W. Zahnley, Manhattan, Kansas.

C. W. Leggatt, Ottawa, Canada, was appointed Editor of the *News Letter.*

REPORT OF THE SECRETARY

In compliance with action taken by this Association at the 28th meeting in Rochester in 1936, application for membership was tendered to the officers of the International Seed Testing Association. Under date of October 24, 1936, Mr. K. Dorph-Petersen, President of the international association, advised in part; "I was extremely delighted to learn the desire of your association and beg to welcome it very heartily as a member of the I.S.T.A."

In further compliance with action taken by the Association at the 28th annual meeting, a communication was directed to the Secretary of Agriculture, Washington, D. C., which read as follows: "I have the honor to advise that the Association of Official Seed Analysts of North America at its annual convention at Rochester, New York, in June, 1936, moved to:

" 'Communicate to the Secretary of the United States Department of Agriculture its appreciation for the assistance in seed control in the many states accomplished under the provisions of the interstate clause of the Federal Seed Act; and that in view of the damaging effect of the increasing use of certain types of misrepresentations that do not come within the present provisions of the Act, there is a need for a revision of its provisions that will make it possible to:

" '(1) Institute seizure proceedings when seed is misbranded in interstate commerce in a false or misleading manner.

" '(2) Institute criminal proceedings against those guilty of making false or misleading representations in interstate commerce.'

"It is the opinion of the Association that seed which is labeled in a false and misleading manner should be subject to seizure. Under the present wording of the Act seed must be misbranded in a false and fraudulent manner before it is subject to seizure. Criminal action under the present wording of the Act is justified only when the seed is knowingly labeled in a false and fraudulent manner. The Association feels that this places an impossible burden upon the Government and lessens the assistance the Federal Seed Act would otherwise be able to render to the States in the control of certain practices in the seed trade that are injurious to the agricultural industry."

Under date of November 10, 1936, Mr. M. L. Wilson, then Acting Secretary, replied to the Association as follows:

"The Department of Agriculture recognizes that advances in the field of seed analysis, increased knowledge with respect to identification of seed, and developments in the trade may make it seem advisable to modify the provisions of the Federal Seed Act to make it more helpful. The suggestions of your Association are along this line.

"Another possibility considered in the Bureau of Plant Industry is to obtain a Federal statute that would require the labeling of all seeds in interstate commerce, the act to be administered by the Bureau in cooperation with the seed control officials of the States. With recognition of the contributions made by your Association in the field of seed testing and the development of seed control in many states, we would be pleased to have your considered recommendations in regard to the desirability of such a statute."

This matter will no doubt be discussed further in the reports of the committees on legislation and interstate labeling. It would appear proper, following these reports, for the Association to consider the request of the Department of Agriculture and take action upon such recommendations as it wishes to make.

There were received from the former Secretary approximately 2,000 copies of Proceedings up to and including the 22nd. The suggestion of offering these for sale at $1.00 per copy was approved by the members of the executive committee. An announcement relative to this was included in the June issue of the *News Letter*. There have been a number of requests for old copies of the Proceedings since that time. Unless there is objection registered by the members of the Association it is the Secretary's plan that these old copies will be offered for sale at that price to members of the trade and others after opportunity has been afforded the official analysts, agricultural libraries, and commercial analysts to obtain their missing numbers.

There are on hand approximately 200 copies of the 27th and 300 copies of the 28th Proceedings.—W. A. DAVIDSON, *Secretary*.

REPORT OF THE AUDITING COMMITTEE

JUNE 1, 1936, TO AUGUST 15, 1937

Balance as of June 1, 1936		$1,732.91	
Receipts:			
Laboratory dues	$850.00		
News Letter	29.00		
Proceedings	190.00		
Accrued interest	7.33		
		$1,076.33	$2,809.24
Disbursements:			
Stationery	$ 30.37		
Postage—			
Secretary's office	53.00		
Research committee 1935–36	34.58		
News Letter supplies	11.82		
PROCEEDINGS (1936)	539.31		
Dues Int. Seed Testing Assoc	50.00		
			$719.08
Balance on hand August 15, 1937			$2,090.16

(*Signed*) W. O. WHITCOMB
(*Signed*) F. A. MCLAUGHLIN

REPORT OF THE EXECUTIVE COMMITTEE

Following adjournment of the regular sessions on Thursday afternoon, June 18, 1936, at Rochester, New York, a meeting of the executive committee was called by Mr. Elliott.

Those present, in addition to Mr. Elliott, were Miss Sirrine, Mr. Whitcomb, Dr. Porter, Mr. Allen, Mr. McLaughlin, Dr. Leggatt, Mr. Wright, and Mr. Davidson.

It was moved by Mr. Whitcomb, seconded by Mr. McLaughlin, that the Association hold the 1937 meeting at Washington, D. C., sometime during the last week in August or early in September. This was acted upon favorably.

The committee also acted favorably upon the motion by Mr. Wright, which was seconded by Mr. Allen, to appoint a publications committee consisting of Mr. Whitcomb, Mr. Munn, and Dr. Leggatt, and that before any change in policy be considered it be referred to the executive committee.

The committee also met at 10:00 a.m., August 22, 1937, in Washington, D. C. Those present were Mr. Elliott, Miss Sirrine, Mr. Whitcomb, Dr. Porter, Mr. McLaughlin, Dr. Leggatt, and Mr. Davidson.

The chairman appointed Mr. Whitcomb and Mr. McLaughlin as a committee to canvass the ballots and audit the treasurer's accounts. Mr. Allen was elected Vice-President and Mr. Davidson Secretary-Treasurer for 1937–38. Miss Sirrine automatically becomes President for 1937–38.

A letter from Dr. G. F. Christie, formerly President of this Association, and now President of the Ontario Agricultural College, Guelph, Ontario, inviting the Association to meet there next year, was read to the committee.

It was the expressed opinion of the members of the executive committee that the various committee reports be fully discussed by the members of the committees prior to the meeting and presented to the Association in as concise form as is feasible; and that recommendations in those reports be supplemented by written motions to be presented to the Secretary at the earliest convenience, that they may be mimeographed for distribution prior to final consideration and action later in the session. The need for definite action on matters that have been given due consideration was emphasized.

The committee authorized the Secretary-Treasurer to sell copies of the 23rd, 24th, 25th, and 26th Proceedings at $3.00 per copy.

Other matters that seemed to warrant consideration by the Association include:

1. Qualifications for membership in the Association.
2. Representation in the Seed Council of North America.
3. Advisability of bonding the treasurer.
4. Continuance of all 5 regional members in the research committee and the selection of its chairman.
5. Application in the rules of the results of the work of the research committee on methods of testing.—G. A. Elliott, *Chairman.*

REPORT UPON THE EIGHTH INTERNATIONAL SEED TESTING CONGRESS

M. T. MUNN[1]

Delegate from the Association

A report upon the Eighth International Seed Testing Congress of the International Seed Testing Association which the writer had the honor and the pleasure of attending as the official delegate of this Association, must necessarily be very brief. Since all of the technical papers and much of the attendant discussion will be printed in full in the formal proceedings, it will not be necessary to discuss those at this time; suffice it to say, however, that they were generally of technical character and definitely showed progress in the field of seed testing. The reports of the standing committees, some of which were very complete and exhaustive, lead in most instances to the adoption of a policy, practice, or procedure.

The illness of President K. Dorph-Petersen, which prevented his attendance, was greatly regretted by every delegate since it was his unbounded enthusiasm for the welfare of the Association through all the preceding years, and particularly at the Congresses, that served as a stimulus to all activities. His absence, however, proved to be a great incentive to other members to take hold of the affairs of the Association and thus fill in the gap created. To President Dorph-Petersen's very capable secretary, Miss K. Sjelby, our thanks are due for the excellent manner in which she arranged the affairs of the office of the president and cooperated fully with the local organization committee and the executive committee in planning for a very successful congress.

The local Swiss organization committee had made every possible arrangement for the success of the congress and the welfare of the delegates from the moment of their arrival in Zurich until the time of their departure from Switzerland at the close of the excursions. The very unusual excursions, which lasted through five delightful days, gave all an opportunity to see much of what was being done in agricultural Switzerland as well as to see the scenic mountain grandeur of the country.

To members of this Association, and particularly to those who are interested in any way in international commerce in seed stocks, perhaps the most significant thing of interest is the way in which the International Association, through its various committees and International Rules for Seed Testing, can facilitate the passage of vital seed stocks in export and import channels through accurate, complete, and uniform descriptions of the goods. The original aims of the International Association to advance all questions connected with the testing and judgment of seeds have been partially realized. There still remains much to be done. The one object stated in the constitution of the International Association, and in which our Association has been most vitally interested and upon which it has given formal expression from time to time, is that of "the formulation of uniform methods and uniform terms in the analysis of seeds in international trade". Our Association, realizing the difficulties and the uncertainties which have existed, due to the inclusion in the Rules of two widely divergent methods or concepts of mechanical

[1]Div. Seed Investigations, N. Y. State Agrl. Expt. Sta., Geneva, N. Y.

purity analysis, have urged the International Association to give this matter careful study. Even though this study has been urged for years, it was only just previous to this Congress that definite instructions were given to participants to carefully consider and study the two methods and then apply them both to the referee samples submitted. The effort produced a considerable body of data which were discussed during one day preceding the Congress, but, unfortunately, these data were considered almost entirely upon the basis of what result each participant secured and how it agreed with some other value rather than why the determination was made in that manner and how the value did and could bear the closest relationship to the seeding value of the seed stock as it actually passes through commerce to the ultimate planter. Even though plenty of opportunity to discuss the question of the two purity analysis methods, namely the SM and the QM, was promised, only a few minutes were finally made available in a much too crowded program. No opportunity was available to discuss together the principle involved in what is known as a mechanical purity analysis as distinguished from what should constitute a viability test. The results of the comparative purity analyses and germination tests, which were reported, showed quite plainly that there is a great confusion of ideas of what a purity analysis should comprise, or, on the other hand, how far the determination of the viability test should be allowed to encroach into the purity analysis laboratory. There are those who would make a partial germination test, even a mental one, in the purity analysis laboratory and then make still another complete germination percentage test in the germination testing laboratory. The abuse or deception from this latter procedure appears when such germination test figures are quoted alone as has been done rather frequently in the past, much to the confusion of seedsmen and the embarrassment of many competent laboratories. These abuses have been so pronounced that the American delegates offered a resolution to the effect that no germination test percentage should be quoted for seed stocks going into international commerce without its accompanying purity analysis percentage figures. The difficulty seems to arise over the confusion in the minds of some as to whether, in this important practical application of seed analysis and testing, we should accept the strict botanical definition of a "seed" or whether we should work uniformly upon the more practical basis of a liberal or possibly academic definition of whether or not each and every entity, unit, or individual in the population of a stock of seed is to all intents a seed having mass, weight, volume, or life and then later permit each separate determination, whether of weight, mechanical purity, varietal genuineness, viability, vitality, or disease condition to speak for itself. The results of the analyses and tests reported upon the replicate samples showed plainly that in practice there is, as might be expected, a wide degree of variation in interpretation of the definition of pure seed under the Stronger Method (SM) as it is stated in the Rules. There was also evident a tendency on the part of some analysts to recede from the extreme interpretation of a pure germinable seed comprising the pure seed, toward the principle or idea of "pure seed as a component part" as set forth in the definition of pure seed under the Quicker Method (QM). There were offered as compromises between the two methods, two or three plans or interpretations. Each of these, however, had as its handicap the idea of searching the seeds in the purity analysis laboratory for an embryo or evidence of life or ability to grow

which is incorporated in the present SM definition and which is so time-consuming and is also open to such wide degrees of interpretation based upon changing judgment rather than upon the premise that it is safer to allow the question of life or viability to be definitely settled by the germination test as it is made in the germination room where all types of seeds making up the bulk or volume offered for seeding purposes are included without reference to their predetermined ability to grow. It did seem evident to an increasing number of workers that the next step for the Association to undertake is to thoroughly consider the principles involved and get them clearly in mind and not give so much thought at the moment to the numerical results, because when principles are defined and practices unified, the numerical results fall uniformly within those defined limits. Moreover, it was thought that the WHY or REASON of any particular method or procedure must be studied as well as the HOW or what RESULTS are secured. It is only by such a procedure that progress and uniformity of results can ever be attained and the Rules made definitely uniform upon which to base the International Certificates which are, after all, the final and useful application or outcome of much of this cooperative work.

In all of this cooperative work, our Association can do its part. The experience we have had in formulating rules of practice and procedure should stand us well in hand when considering this important matter of unifying the worldwide methods of testing seeds. We have a right to expect progress because of the large imports of seeds entering our countries. Progress may seem slow at times, but there does appear to be a definite trend toward a sincere willingness on the part of the important seed testing stations to undertake the accurate and faithful evaluation of the seed stocks they propose to describe as having values for seed purposes.

The invitation which was extended to hold the next Congress of the International Association on this side of the ocean in 1940 was gladly and unanimously accepted. We will be glad to welcome delegates here. Our Association should again start plans for a successful Congress in about three years. Much needs to be done but through such cooperation as has been shown in the past it will be enjoyable and pleasant work for all of us and the final outcome will be very beneficial to all concerned.

PRESIDENTIAL ADDRESS

WHAT OF THE FUTURE

GEORGE A. ELLIOTT

Seed Branch, Department of Agriculture, Ottawa, Canada

This is the twenty-ninth anniversary of the foundation of the Association of Official Seed Analysts. My thoughts spanning the years that have gone are compounded of gratitude to those who have borne the burden with the object of furthering the work of our Association. Man is by nature an optimist. When his dreams are unfulfilled, when he falls short of his objective, he finds comfort in the thought that there is a tomorrow holding a promise of better things, and he faces the dawn of another day confident that his efforts will bring their reward.

What of the days to come for our Association? In the first place, I wish to re-iterate to all my deep gratitude for the trust you have reposed in me. I wish to thank the membership for the honour bestowed upon me in making me your president one year ago. It has required no small effort on my part to attempt to follow in the footsteps of the leaders who have preceded me. With a membership steadfast in its loyalty and allegiance to an organization that has fully justified its existence, we should not fail to draw measureably nearer our objectives during the coming year. Many tasks face us, and if we are to make headway all must do their part.

Last year, previous to our annual meeting at Rochester, we heard a great deal of the lack of uniformity in tests. As far as I am concerned, I have not had one complaint drawn to my attention this year. I would like to think that it has been the work and organization of our Research Committee that has brought about this happy state of affairs. I believe that the sending out of what are called "Referee Samples" to all commercial analysts has had something to do with all interests having a fuller appreciation of some of our difficulties. In this connection, I fully realize that there is considerable lack of uniformity in the matter of seed testing, and I consider that many of our difficulties and differences are due, in no small measure, to a lack of appreciation of this subject.

In one referee sample of beet seed sent out this year to both official and commercial laboratories, the results of which were brought to my attention, there was found to be considerable variation—much greater than one would expect to find from what are considered quite competent laboratories. We all must realize then that variations, greater than what we might theoretically expect, are bound to occur. What I wish to impress upon all present is the fact that there is as yet considerable variation in the results obtained between different laboratories. It is also realized by all that the quantity being analyzed either for purity or germination is not sufficiently large. Those who are better versed in the matter of statistics than I am will have an opportunity later in the program of bringing this matter more fully to your attention.

In last year's Presidential address, Mr. Whitcomb drew to your attention ten suggested remedies for some of our difficulties. I trust that all have studied and have given serious consideration to these for I am sure that they would be of great assistance to all in bringing about greater uniformity in seed testing.

On our Association crest there are inscribed these four words, Analysis, Inspection, Education, and Research. This very well embodies the full scope of our Association activities. Would it not be possible to so organize as to have our committee work cover these four fields? No doubt in the organization of the various laboratories comprising our Association, the set-up is very different. In some, the person in charge is interested primarily in the testing of seeds, in others his interest may be largely in law enforcement. The thought has occurred to me from past experience that our program might be so arranged that those interested in seed analysis and research might meet at the same time as those interested in legislation and education. I can see many difficulties in an arrangement such as this but I believe it to be worthy of consideration. Probably one of the causes of the lack of uniformity in results of analyses is that some of those in charge of laboratories are more interested in control work than they are in the analyzing of samples. It must be admitted that, although the two lines of work are closely related, they are vastly different and, in some cases, either one or the other of the two lines of work is bound to suffer.

Last year, we featured to some extent the work of our Research Committee and it may be truly said that, with the exception of counting weak sprouts, soil testing, and still more recently the use of prechilling, our methods in both purity and germination have not been changed greatly over a period of 10 or 15 years. It would seem that with the sample of beet seed mentioned above that our details of technique in testing must be at variance or else the differences noted would not have occurred. If the temperature, amount of moisture, and medium were the same, and there is no reason why they should not be, then the results should be more in line with what might be theoretically expected. It is one of our first duties to watch these points very carefully, and if we do, then these variations will not occur. This, together with a sufficient amount of seed tested, should, in a large measure, overcome many of our difficulties. Some may contend that the correctness in sampling and mixing has a great deal to do with the lack of uniformity in the results of testing. This may be true to some extent, but I believe that our first consideration as seed analysts should be to correctly analyze the sample after it has been received at the laboratory. It would greatly enhance our Association and the reputation of our individual laboratories and the science of seed testing were we more concerned with analyzing a few samples properly than in trying to pile up a record number of samples done in any one year. I fully realize the difficulties encountered in regard to this during the busy season of the year.

Last year we changed our name to the Association of Official Seed Analysts. We have with us to-day those who attended the meeting of the International Seed Testing Association at Zurich. We shall have the privilege later of hearing their report of that Congress. The aims and objects of the two associations should be the same. Would it be possible or advisable to have the two Associations merge into one, having Eastern and Western sections? This idea was advanced to me some time ago.

Let me direct your attention for a few moments to what is called an official laboratory. It has been impossible for me to find any stated definition for this in our constitution. It appears to me to be any seed laboratory connected with any government institution. It would seem that this is the only requisite in order to become an official seed laboratory. Would it not appear to anyone that this might be one of the causes of our lack of uniformity? Should all official laboratories not have a certain standard or rating? For a few years this Association attempted to certify or rate our different laboratories but this was dropped after a few years' trial because it was found not practicable. But should it not be compulsory that they should partake in at least the majority of the referee samples sent out? Surely this is not asking too much if they are at all interested in our work. Do we wish to have them and accept them as members only for their annual fees? Would it not be advisable to take a page out of the book of our coworkers, the Commercial Seed Analysts Association, in which definite standards are set up before a laboratory can become a member? I hope that the report of the Research Committee will reveal the number of referee samples partaken in by the various laboratories.

Probably on account of the time and location of our annual meetings, it has been impossible for some laboratories to attend. It would appear then that some effort should be made by this association to acquaint them with our work and to secure their more active interest. A committee has been very active during the past year on this question, and I trust you may give due consideration to their report.

The retention and strengthening of public confidence and good will in seed testing and in our Association is our responsibiilty and should continue to be our constant concern.

In conclusion, I should like to express my appreciation of the privilege I have had of being your President for the past year. I have always been actively interested in the work of the Association. I feel that it should serve a most important function in the commerce of seeds. I have been glad, therefore, to do what I can to advance the interests of the Association. I have been very happy in my relationship with the Executives who have been associated with me. They have been sympathetic, courageous, broadminded, and willing to help in every way possible.

I shall look forward with interest to the progress of the Association of Official Seed Analysts in the future, and while I shall not be responsible for directing the affairs of the Association, I shall be glad to be of help in any way I can.

ADDRESS

THE SEED-BUYING PUBLIC

OLCOTT F. KING[1]

National Association of Commissioners, Secretaries, and Directors of Agriculture

At the request of Commissioner Brock of California, who is President of the National Association of Commissioners of Agriculture, I have the honor of meeting with your association to represent the Agricultural Commissioners of the several states.

We will all agree, I think, that the seed analysts occupy the front line trenches in any seed regulatory work where we (the departments of regulation) are supposed to protect the innocent public from fraud and aid the honest merchant and producer in meeting competition from the Headliners, Loud-speakers, and the High Pressure distributors who still realize that Barnum was right—"The public likes to be fooled." Ignorant and careless buying by the public make regulation difficult and sometimes ridiculous.

If I have learned anything in my four years of regulatory work, it is, that *one* of the difficulties of making quality count against the high percentages of profit in low grade and misrepresented merchandise (where so much can be spent on advertising and distribution) is that Barnum *was* right.

Headlines and loud speakers are about as far as the average public mind will cooperate, therefore after the seed analyst and the State Departments of regulation have placed in the hands of the buyer all the necessary information, about all it takes to sell worthless seed mixtures to the millions of careless buyers, is a pretty picture and a popular price. The pity of it is that the high grade seed salesmen cannot afford any such broad distribution to little stores of all kinds that dispense in the springtime, to those who will spend good money for bad merchandise, as in "Faith and hope they plant those seeds."

Even the fact that the vendor of these seed mixtures has complied with all the rules and regulations, we still permit him to sell worthless seed mixtures by the ton because the buying public will not measure values with the price charged. The public will read only the headlines on the package and not the analyses which are put on by the Departments for their protection. Regulation would be simple if the public would use reasonable intelligence in measuring values when they buy.

The price we pay for innumerable necessary articles (and many unnecessary ones) is due to the fact that quality goods cannot meet the competition of advertising and distribution because of the smaller margin of profit on quality goods.

An attempt to inform the buyer is apparently being made in some states by so called "Departments of Consumer Relations", all of which may be effective but contains much dynamite if our experience in Connecticut is any criterion.

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[1]Commissioner, Department of Agriculture, Hartford, Connecticut.

The question raised by us, the regulators, is how far we should go beyond simply reporting the facts. I have here reports from my State Department on seed mixtures in which we tell the story of your work as seed analysts. We show in one year a seed mixture, which has probably the widest distribution in the state, containing practically no lawn seed of any permanent value, the most expensive seed from a standpoint of actual value. We find such variations as for instance a mixture sold by a small store on one side of the street as *Timothy-Clover Lawn Seed* for ten cents per quart, when Timothy was very cheap and Clover was very scarce (in the mixture). Across the street, in one of Connecticut's largest Department Stores was featured the same mixture under another name and selling for 28 cents a pound.

Our report for 1934 contained two pages relative to Lawn Mixtures and model formulas for comparison with the enclosed analyses. This was given extensive publicity in the press of the state, calling the attention of the public to the necessity of reading the labels put on by the seed analysts.

The following year, our famous brand of seed again appeared without any label. After considerable publicity which, if the facts had not been true, would have placed us in jail, we warned the public not to buy seed without labels. We also informed them as to the value of this lawn mixture.

This publicity brought in a truck load of labels to go on the packages and thus comply with the law. But the public kept right on buying. This *valuable* (?) mixture contained the following:

0.04% permanent lawn seed
50.07% non-permanent lawn seed
49.00% inert matter
0.89% weed seeds
28 plantain seeds per ounce
Low in germination

A rather expensive lawn mixture at 25 cents per package, whatever the size of the package.

TABLE 1.—*Cost versus money value of certain lots of seed mixtures in 1935*

Number of samples	Cost per pound in dollars	Actual money value percentage of cost
2	$.20	50
1	.23	60
4	.25	60
1	.26	47
5	.30	55
12	.35	63
8	.40	75
7	.45	72
8	.50	83
1	.54	53
3	.55	83
4	.60	90
4	.65	90
3	.70	91
3	.75	90
1	1.10	95
1	1.25	98

You can readily see that no high grade mixture can compete in distribution to the retailer if the public is irresponsible in its buying and thinks only of price.

In closing, let us glance at a report for the year 1935. An analysis of special mixtures, showing costs versus real money value is given in Table 1. The report was based on 69 samples. Cost per pound ranged from 20 cents to $1.25.

From the above figures it would seem that your good work and the regulatory work of our State Departments in attempting to aid the consumer are of little avail unless by some magic we are able to break down the Barnum theory that—"The public likes to be fooled."

ADDRESS

PROBLEMS OF THE SEED TRADE, YOURS AND MINE

H. H. MILLER[1]

American Seed Trade Association

For the honor of representing the American Seed Trade Association and the privilege of addressing the official seed analysts at their annual meeting, I am deeply grateful.

Personal.—Beginning as a seed analyst in 1902, in the Dominion Seed Laboratory at Ottawa, I have spent my life in some phase of the seed business. When the Dominion laboratory was organized by George H. Clark, the Canadian Seed Commissioner, it was necessary to obtain the services of Mr. Michaud of the Zurich Laboratory to train the first analysts.

In 1906, it was my good fortune to establish what I believe to be the first commercial field seed laboratory on this continent for the Albert Dickinson Seed Company at Chicago. Now, as the general manager of a seed company, I have had experience on both sides. It was our honored friend, Charles A. Heath of Chicago, at that time associated with the Dickinson Company, who had the vision that furnished the impetus for the establishment of that laboratory.

The New Era.—A few days ago, Mr. Heath and I were reminiscing a bit. He told me of the events which led to the establishment of that laboratory. Maine had passed a seed law in 1897 with which the studious Mr. Heath was familiar. He had been trying to establish grades of seed and had contributed a great deal to that end. One day he approached Mr. Dickinson and now I quote Mr. Heath: "Mr. Dickinson, I have a copy of the Maine seed law. This checks with what I have tried to do and I want to go to Orono, Maine. 'Alright', said Mr. Dickinson. I went. The day was spent with Director Woods and I enjoyed dinner with him and his family. He told me more in an hour than I had thought of in ten years. I saw the picture. There was a turn-over coming in the method of handling seed. I was more determined than ever to clean seed to meet the provisions of the Maine Law and to my knowledge this marked the beginning of merchandising seed on the basis of purity rather than the more or less general terms of 'prime', 'choice', and 'fancy'. It marked the beginning of a new era in the seed business."

It appears that from the beginning aggressive and discerning seedsmen have cooperated with and lent encouragement to the furtherance of your program.

Cooperation.—We must not loose sight of the fact, that the primary function of the seed business is the same as yours—that is, to improve the quality of seed offered to farmers. Manufacturers of seed cleaning machinery, seed analysts and law enforcement agencies and the seed trade should "pull together". Either of us would be vain, if we said we were above criticism. To cooperate successfully, we must have a mutual understanding. Our viewpoints are necessarily opposite, but there is the common ground. Perhaps,

[1]Manager, Funk Bros. Seed Co., Bloomington, Illinois.

the seed trade in some states have failed to offer you an opportunity to learn about their problems. If that is so, the seed trade of those states needs a new policy.

Perhaps, the officials of the seed laboratory have not always made use of their opportunity. I believe that the relationship existing between the Division of Seed Inspection and the seed trade in my own state is an example to emulate.

Here, I am reminded of a story which is illustrative: 'John's and Mary's married life had been interrupted by short intervals of happiness. One fine Sunday morning, John hitched up his fine dapple grays and with Mary beside him was on the way to church. Mary was feeling some emotion, perhaps remorse. She noticed with pride, the even and spirited stride of the horses. After many minutes in silence, she said, "John would it not be wonderful, if we could pull together as those grays are doing?" John's reply was, "we could, if we only had one tongue between us".' Now, John is not symbolic of the officials of the Illinois Division of Seed Inspection, nor does he represent the spirit of the Illinois Seed Trade.

There is a standing invitation to the representatives of the Division of Seed Inspection to attend any and all of our meetings where our problems have been openly and frankly discussed. Constructive criticism is invited at all times and we have both profited by this relationship. It has not been necessary to have but one tongue between us. Only last fall, the Division of Seed Inspection was host at a dinner given to the Illinois Seed Trade at which a new set of rules and regulations were submitted and amendments to the seed law were discussed. The curious thing about this was that the head of the division, who presided, called for a vote from the seedsmen on whether or not they favored the adoption of the regulations. From more than 125 representatives of the seed trade present, there was not a "nay". Though the regulations imposed further restrictions and added work on the seed trade, they seemed to be necessary to the enforcement of the seed law. That exemplifies cooperation.

Conscientious Seed Dealers Want Efficient Enforcement of Seed Laws.— Without enforcement of the seed law and an efficient inspection service, the excellent work of many of our state laboratories is almost nullified. Our state laws for the most part have plenty of teeth in them. If they haven't, the members of the seed trade will gladly lend their influence to get them.

For a seed company to invest in a complete cleaning equipment, involves a respectable outlay of capital on which interest must be charged. The proper cleaning of seed involves shrinkage which necessarily adds to the cost of the seed and requires a higher selling price.

The discriminating buyers are too few. The majority are price buyers and when the itinerant seed dealer comes along in his truck, seed that is far below the requirements of the seed law is often sold at a price a little below that obtained for good seed. An equal menace to the conscientious seed firm is the mail order seed house which is often beyond the jurisdiction of a state law. With highly colored catalogues, containing extravagant statements, farmers are influenced to buy seed of low quality at prices sometimes below wholesale or car lot prices.

Then, the "over the fence" trading between neighbors without analysis or germination test or labels, is prohibited, I believe, by most state laws. These instances place the conscientious seed dealer in an embarrassing posi-

tion. Too few farmers buy on the basis of quality, price being usually the determining factor.

Again, may I compliment certain state law enforcement officers for the courageous stand they have taken and the aggressive campaign which they have conducted. That is why the seed trade is anxious to support suitable federal legislation and to assist states in securing efficient inspection service. For this condition the seed trade is not without blame. For selling screenings to certain seed companies, certain members of the trade stand indicted but that is not the present policy of the seed trade and every effort is being made to eliminate this practice.

The reputation of any seed house is made by the quality of seed it offers for sale. Great care is exercised in maintaining standards. We believe that it should be and it is the policy in some states to give the seed dealer the benefit of the doubt. They are all willing and most of them glad to correct errors. Law enforcement officers should be careful not to jeopardize the reputation of a good firm. We may fairly assume that your group and my group intend to do the right thing, but as with human beings, we are never on the "golden mean" except when we are crossing it.

Laboratory Tests.—The analysis of seed for purity is purely mechanical and subject to human error. That between experts there will be slight differences is expected, but those differences are usually within the range of tolerance. When a seed company sends a sample to several laboratories and receives widely varying reports, some laboratory is going to be subject to criticism and the confidence of the seed dealer will be lessened or even destroyed. Certainly too much stress cannot be put upon uniformity in methods among laboratories. We are indebted to Dr. Porter of your organization for his persistent and diligent studies along this line. As much of the human factor must be eliminated as possible. You all appreciate the importance of uniformity. It is your problem. The seed trade commends you on your efforts to solve it through referee tests and otherwise. The American Seed Trade Association stands ready to cooperate with you.

Hard Seed.—Hard seed is a perennial problem and perhaps its full solution awaits. The lack of uniformity among state officials as to interpretation of hard seed at present causes endless confusion in labeling. The work of Mr. Stone, Mr. Whitcomb and others is appreciated and some day, we will know all the facts. The seed trade awaits this discovery and then when "facts begin all argument ceases".

Noxious Weed Seeds.—It may be hard for you to appreciate the difficulty seed firms experience when doing business in a number of states. Today there is a total of eighty-five weed seeds listed as noxious in the seed laws of the several states. Among the states, the number varies from four (in Massachusetts) to nineteen (in Indiana). That certain perennial weeds have been widely distributed through field seeds is certain, but should those weeds, which yield readily to cultivation, be classed as noxious, especially under the present farm practices?

As a land owner, I am intensely interested in weed control, but is that control to be centered only on the seed trade? Investigations on the weed content of soils show it to be heavily contaminated with weed seeds. Each year, untold numbers of weed seeds are spread over the land by wind, animals, flood waters, and otherwise. It is not surprising then that investigators tell us that there are many hundreds of pounds of weed seeds in every acre of soil awaiting an opportunity to grow.

The solution to the weed problem appears to be not so much a problem for the seed trade as for the farmers. Illinois for one state, is becoming "weed conscious". Laws affecting weed control have recently been amended and an aggressive campaign is being waged, not only against Canada thistle and field bindweed, but against all weeds that menace agricultural production, interfere with public health or mar the landscape.

It is a gigantic task, but you would be surprised to see the response in cities, as well as in the rural districts. If the present program can be carried out for five years with as much success as is already evident, we will see a great improvement in the farm run seed in Illinois. There is no compulsion except with Canada thistles and bindweed, but there has been a vigorous educational campaign conducted by the Illinois Division of Seed Inspection. After all, weed control is a matter of good farm practice and not entirely a seed problem.

Would it be possible for your group to determine just what weeds are of such agronomic importance that they should be classified as noxious and thus alleviate one difficulty of the seed dealer? It appears so to us. So many of the weeds, whose seeds are classed as noxious, quickly yield to cultivation or other methods that prevent reseeding. It would be a signal service to agriculture if every seed laboratory was provided with the personnel and facilities to promote in cooperation with other agencies a definite weed control program.

Earlier in my remarks I have referred to the exchange of low quality seeds among farmers themselves. The recognition of this problem by all of us is ample evidence that the work of seed analysts and the seed trade is not yet fully supported by farmers who use the seed. This emphasizes the need for further educational work among those who actually control the situation on their own individual farms.

We have in this broad agricultural land of ours an important adult educational system among farmers which can be directed along certain lines if the proper officials are convinced of the importance of the problem at hand. I refer to the agricultural extension service and the county agricultural agents.

State Department of Agriculture officials should and in most states do work hand in hand with their respective colleges of agriculture. Some one in the agricultural college is responsible for the administration of the extension service in that state. Through this avenue lies a way of approach which has not been fully utilized.

True it is that this is not the only educational medium which is available. It is one which it seems to us may be available to the seed analysts of the country to further their program.

Certainly one reason we are not making more progress with the weed problem is because efforts in the past have been too largely directed toward the handler or merchandiser of seeds rather than the user. If we admit that the farmer does not yet recognize the importance of weed control on his own farm, it would appear that the educational approach mentioned above may be worthy of further trial.

I believe you will all agree that the effectiveness of the work done by seed analysts and merchandisers of good clean seed cannot be most valuable unless their work is more fully appreciated by the actual seed user and backed up by farmers themselves. I would like, therefore, to urge that

further effort be directed towards an educational program which will help farmers not only to realize true value in good seed, but to cooperate with us in weed control. This in the last analysis will do much to further the program in which all of us are interested.

As a title for this paper, I chose to discuss the problems of the seed trade as your problems as well as mine. I have merely suggested some things without going into detail.

The American Seed Trade Association has invited the criticism of the Agricultural Experiment Stations and there is available here for each of you a copy of that report, if you care for it. It is a complete picture of the splendid work and excellent cooperation of experiment station officials and speaks for itself. In my opinion, neither the seed analysts nor the seed trade has been given full credit for the service they have rendered agriculture. Perhaps, that is our fault. Would it not be a good policy for seed analysts to avail themselves of every avenue of publicity? It will help you and in turn help us.

The platform on which the seed industry is functioning today is basically sound and in our efforts to serve American agriculture, we need you and we hope that you feel that you need us.

ADDRESS

SOME SUGGESTIONS FOR GREATER UNIFORMITY OF TAGGING SEEDS

A. J. ZAHORIK[1]

President, Association of Commercial Seed Analysts

On behalf of the Commercial Analysts' Association, I want to thank your organization for your kind invitation to give a short talk on some matters that will tend toward greater co-operation. Your annual invitation alone has been a splendid expression of a desire to co-operate with our organization and the seed trade. I assure you that we appreciate the opportunity to be with you. As both organizations have much in common, a deliberation on some problems should be of mutual benefit. Your President, Professor Whitcomb, presented a paper last year that could be used as a preface to my talk. It was entitled "The Other Fellow's Viewpoint". He brought out very clearly the necessity of considering the other man's problems.

Because of the unique business position of the Commercial Analysts which makes them a connecting link between Official Analysts and seedsmen, many problems of the latter become the Analysts' problems, although not of an analytical nature. It must also be understood that the business position of Commercial Analysts permits only a very limited amount of research work. Accordingly, problems for your consideration are largely those that have been encountered in carrying out rules and regulations for seed analysts, tagging of seeds, and seed legislation. It is the hope of the Commercial Analysts that in presenting our problems that these will not be

[1]L. Teweles Seed Co.

considered as criticisms but merely as suggestions as a means toward an improvement of problems present.

Uniformity of seed legislation and seed tagging still deserve the attention of every Official Analyst. Through the joint efforts of the Official Analysts and the seed trade, a Uniform State Seed Law was drawn up several years ago for the guidance of States proposing new seed legislation. The present multiplicity of tag requirements for seed is confusing, hampers service, is a contributing cause of incorrect labelling, and is a great expense to dealers.

Some people may contend that these problems are not those of analysts. However, any question regarding seeds that concerns the farmer concerns every one of us. We must be more than seed analysts. Narrowing the field of seed testing means a narrowing of the possible service that can be rendered.

To appreciate the difficulties encountered by Commercial Analysts connected with large establishments doing an interstate seed business, allow me to call your attention to the questions of hard seeds and noxious weeds in connection with the tagging of seeds. With forty-six different state seed laws with which to contend, consider the difficulty encountered in trying to tag properly during the rush season several hundred orders a day, ranging from a few pounds to several hundred bags, and each order with one to a dozen items. A multiplicity of different kinds of tags and a variety of information is required to comply with the seed laws.

There appears to be a lack of field experimental data to substantiate the different ways of reporting hard seeds on tags. From evidence just compiled from different states, there are nine ways of reporting hard seeds. If field experimental data are available, they ought to be made the basis for reporting hard seeds. However, if no field tests have been made, the agronomic value of hard seeds should be ascertained through experimentation.

That hard seeds have an agronomic value under certain conditions is generally agreed upon by agricultural leaders. The contention is frequently made that if the germination of hard seeds is delayed too long after a legume crop has been shown, subsequent plants will be of little or no value. Just to what extent hard seeds may germinate and be of value is a matter of opinion among Official Analysts, and this undoubtedly accounts for the different methods of reporting them.

To evaluate hard seeds as to their agronomic value let us consider their importance from another angle. Under our present system of crop rotation, most of our legumes are sown in some grain crop. Such legumes as alsyke, clover, alfalfa, and red clover frequently appear to have difficulty in growing or surviving for various reasons. This is very evident from the thin stands so often seen after the grain has been harvested. Yet, the seeds mentioned above germinate normally within one week's time. The average number of plants with the usual rate of seeding would be from 80 to 100 plants per square foot, depending upon the kind of seed. Is it not probable that many of the seedlings died in the drought and shade of the grain? Is it also not reasonable to assume that a delayed germination of hard seeds would be desirable? If 10% of the seeds sown were hard, which would approximate eight to ten seeds per square foot, we can readily see to what an extent hard seeds might supplement a thin stand. After Fall rains, the legume crops seem to come to life, and what often appeared to be a poor catch after the grain was harvested, resulted in a good crop the following year, probably due to

the germination of hard seeds. Very often, also, legumes are sown in the early spring on frozen ground in rye or winter wheat. When sown under such trying conditions, many seedlings are in danger of freezing, and, undoubtedly, frequently do freeze during cold nights. Here again, it is the hard seeds that would be the savers of the crop through a delayed germination.

The point that I would like to convey is that the hard seed question is important and worthy of investigation through field experimentation. It is only with such information at hand that we can get a greater unification of opinion and uniformity of reporting hard seeds on tags.

Incidentally, let us inquire into the practicability of the growing tendency of reporting the percentages of sprouts and the percentages of hard seeds separately without totaling them. If we acknowledge the fact that hard seeds have a value, then that fact should be conveyed to the farmer through some statement. At present, it appears that the issue is evaded and the matter of the value of hard seeds is left to the farmer's own discretion. I would suggest that until further research work is completed, the germination and hard seeds be reported separately and totaled on the tag as—"Total Probable Live Seeds." Such a statement would not be a misrepresentation of facts and the farmer would have some assurance that the hard seeds are of value.

Hard seeds may be of questionable value where a legume crop is sown alone in the spring as in the case of vetches.

The greatest variation in tag requirements among the different states is that of noxious weeds. Not only does the list vary greatly in length for the different states but the requirements for reporting weeds on the tag is extremely confusing. Greater unification of the lists and greater uniformity of reporting weeds is very desirable. One state at present designates only four weeds as noxious, another 41. The range varies from 6 to 15. The total number of different noxious weeds of all the states is 85.

It is true that the flora differs in different parts of the United States, but it does not seem reasonable that the number and kind of noxious weeds should be so different even in the case of two adjoining states of comparatively the same soil and climate. There is also some question in my mind as to the wisdom of a long list. The effectiveness of identifying to the farmer certain outstanding noxious weeds is very likely lost if less important ones are included in the noxious list. Farmers are apt to assume that all weeds are more or less of the same noxious character. It must be acknowledged that such weeds as sorrel and common plantain are not as troublesome under farm operation as Canada thistle or quack grass. This situation is being realized and many states are subdividing their list into groups assigning different tolerances to each. It is questionable whether the farmer will differentiate between the different groups and benefit by the law which was designed for his protection.

Just what should be considered a basis on which to judge a weed as noxious is difficult to state. Probably a safe rule would be the difficulty a weed gives to the farmer in fields. Certainly the mere prevalence of a weed should not be considered as a basis, as common ragweed and foxtails, although common, give little difficulty in fields. Neither should weeds that are troublesome in lawns such as plantain, dandelion or crabgrass be included in the list. Nor should a weed be classed as noxious because of its prevalence in waste places. Unless careful discretion is used the list will be-

come very long. A State Seed Council in co-operation with the Official Analyst of a State can undoubtedly choose a list of most troublesome weeds.

If we study a chart showing a tabulation of the noxious weeds of different states, we will note that four weeds are outstanding, namely: Canada thistle, dodder, mustard, and quack grass, and to a lesser degree: buckhorn, corn cockle, wild oats, Johnson grass, wild carrot, perennial sow thistle and wild garlic. The Uniform State Seed Law recommends that the number does not exceed seven.

Seedsmen are interested in proper seed enforcement. A seed law not enforced works a hardship on the dealer carrying out provisions of the law and offers no protection to the farmer buying his seeds, but in reality is an asset to the unscrupulous dealer who pretends to sell his seed in compliance with the law. Such a condition is detrimental to good agriculture.

Unfortunately, there are a great many seed laws on the statute books that should never have been passed. Many of the laws cannot be enforced. May we suggest for greater uniformity and effective seed law enforcement, that officials who are contemplating new legislation bear in mind the Uniform State Seed Law. As previously stated this law was agreed upon several years ago by the Association of Official Analysts and the Seed Trade Associations. Unlike many seed laws it is clear, and an effective weapon against unscrupulous dealers. It is encouraging to note that a number of seed laws have been passed in late years patterned after this law.

In closing, permit me to summarize the suggestions —

1. That the agronomic value of hard seeds be ascertained by field experimentation.
2. That until the necessary information is obtained regarding the agronomic value of hard seeds, the percentage of germination and the percentage of hard seeds be reported separately, but totaled. The total to read "Total Probable Live Seeds".
3. That efforts be made towards a greater unification of noxious weed lists and a greater uniformity of reporting such weeds on tags.
4. That the Uniform State Seed Law be used as a model for new seed legislation.

HARD SEEDS IN LEGUMES: SUMMARY OF LABELING REQUIREMENTS OF STATE LAWS AND METHODS OF REPORTING BY LABORATORIES[1]

W. O. WHITCOMB

For the Legislative Committee

Desirability of uniformity in labeling requirements by the various states has often been stressed by seedsmen. No phase of this problem is receiving more attention at the present time than the labeling of legume seeds which contain hard seeds. Linked with this is the matter of methods of reporting the results of tests on such seeds by official laboratories. A survey of these subjects by the Legislative Committee shows that the seed dealers have

[1]Contribution from Montana State College, Agricultural Experiment Station. Paper No. 103 Journal Series.

cause for concern when shipping seeds into the various states and attempting to so label such seed that it will comply with the state requirements. As a part of this survey, seed laws from 46 states and laboratory report forms from 48 official laboratories were assembled for study and comparison.

STATE REGULATIONS ON LABELING SEEDS CONTAINING HARD SEEDS

Of the 48 states, all except Florida and Georgia have seed laws. Four of these laws specify in the text how seeds which contain hard seeds shall be labeled, while 27 provide, through regulations authorized by law, or otherwise, how the labeling shall be done, and 15 states make no provision for labeling as to hard seed content. A further study of these laws and regulations shows that the labeling requirements which are in effect vary considerably. Some of the labeling requirements are not definite and explicit, while others are very much so.

TABLE 1.—*Rulings by state laws, or by regulations accompanying them, pertaining to the labeling of seed containing hard seeds.*

I Group—*Percentage of hard seed shall not be added to the percentage of germination in main statement but may or may not be added to germination percentage in supplementary statement* 24

1. Shall not be included in germination.
   Maine
2. Shall not be included, but may be stated separately.
   California, Colorado, Indiana, Michigan, New York
3. Shall be stated separately.
   Alabama, Connecticut, Illinois, Kansas, Kentucky, Minnesota, Mississippi, New Jersey, Oklahoma, Oregon, Rhode Island, Texas, West Virginia, Wisconsin
4. Shall not be included in germination, but germination and hard seed may be stated separately and the sum of the two given.
   Maryland
   Virginia
5. Shall be stated separately, but in addition may be added and stated as "Total live seed."
   Montana
6. Shall not be added, no statement of "Total germination," "total viable seeds," "total live seeds" or similar terms permitted.
   Ohio

II Group—*Percentage of hard seed shall be included as part of germination percentage and requirement may or may not be made to state them separately* 7

1. Shall be included in germination and also stated separately.
   Iowa, Missouri, Nebraska, North Dakota, South Dakota
2. Shall be included in germination and need not be stated separately.
   Tennessee
   Wyoming

As shown in Table 1, the 31 states, which regulate the labeling of seeds which contain hard seeds, may be divided into two groups according to labeling requirements. The first of these groups includes those states in which the hard seeds shall not be added to the germination in the main statement, and may or may not be added in a supplementary statement. This group includes 24 states. The other group, which includes seven states, requires that the hard seeds shall be included as part of the germination and that such hard seeds may or may not need be stated separately.

A further study of Group I, shows that it can be subdivided into six sections. Some of these sections might well be grouped together according to effect, but for the purpose of giving the meaning of the law, as nearly as possible, the various states are grouped in this way. Section 1, which consists of Maine, states that hard seeds shall not be included in germination, but makes no further provision relative to labeling. Section 2, which includes the five states of California, Colorado, Indiana, Michigan, and New York, differs from Section 1 in that the hard seeds may be stated separately. Section 3 requires that the germination and hard seeds shall be stated separately, but makes no further provision for method of labeling. This is the largest section of any group and consists of the 14 states of Alabama, Connecticut, Illinois, Kansas, Kentucky, Minnesota, Mississippi, New Jersey, Oklahoma, Oregon, Rhode Island, Texas, West Virginia, and Wisconsin. Section 4, which includes Maryland and Virginia, requires that the hard seeds shall not be included in the germination, but provision is made for stating the germination and hard seeds separately and then stating the sum of the two. Section 5, which consists of Montana, is a liberal one resembling Section 4, in that both require that the germination and hard seeds shall be stated separately, but permit a supplementary statement in which the two are added together. These two sections differ, however, in that Maryland and Virginia provide for stating the germination plus the hard seeds as a sum while Montana specifies in the law that this sum may be stated as "Total live seed". Section 6 is a conservative one and specifies that germination and hard seeds shall not be added in any way whatsoever. Ohio is in this section.

Group II consists of two sections. Section 1 requires that the hard seed shall be included in the germination and shall also be stated separately. The five states belonging to this section are Iowa, Missouri, Nebraska, North Dakota, and South Dakota. Section 2 requires that the hard seeds shall be included in the germination and that they need not be stated separately. Tennessee and Wyoming are in this section.

MANNER OF REPORTING HARD SEEDS BY OFFICIAL LABORATORIES

As shown by Table 2, the official seed testing laboratories representing 46 states and the Federal laboratories of the United States and Canada can be divided into four groups according to the way in which they report germination test results on legume seeds containing hard seeds. The first of these groups includes 41 laboratories which report the germination and hard seeds separately and do not add them together. The second group includes four laboratories which report the germination and hard seeds separately and also state them as a sum. The third group of two laboratories reports the germination inclusive of hard seeds and also states the hard seeds separately. The fourth group, consisting of one laboratory reports the hard seeds as part of the germination and does not state them separately.

Each group has been subdivided into sections to show minor differences in methods of reporting. Apparently the various laboratories have good reasons for reporting in a certain way, and an attempt has been made to show these details.

Group I has been subdivided into seven sections. Section 1 reports germination——% and hard seed——% in conformity with the "Rules for Seed Testing" as adopted by this Association. There are 34 laboratories in this

TABLE 2.—*Manner of reporting hard seeds in legume seeds by official laboratories.*

I Group—*Germination percentage and hard seed percentage stated separately in report, and do not add hard seed percentage to germination percentage* 41

1. Germination————% Hard Seed————%

Alabama	Kentucky	New Jersey	South Carolina
Arizona	Louisiana	New Mexico	South Dakota
California	Maryland	New York	U. S. Dept. Agri.[1]
Colorado	Massachusetts	North Carolina	Vermont
Connecticut	Michigan	North Dakota	Virginia
Delaware	Minnesota	Ohio	West Virginia
Idaho	Mississippi	Oklahoma	Wisconsin
Indiana	Missouri	Oregon	
Kansas	Montana	Rhode Island	

2. Actual sprouts————% Hard seed————% Dead seed————%
   Illinois
3. Germination————% Hard seed————% Dead seed————%
   Iowa
4. Germination————% Hard seed————% Total live seed————% but omit total in reporting.
   Pennsylvania
5. Germination————% Weak sprouts————% Hard seeds————%
   Washington
6. Normal germination————% Weak sprouts————% Hard seeds——% Decayed————%
   Nevada
7. Strong sprouts————% Hard seeds————% Weak sprouts————% Dead seed————%
   Utah

II Group—*Germination percentage and hard seed percentage stated separately in report, and also stated as germination percentage plus hard seed percentage* 2

1. Germination————% Hard seed————%; Germination plus hard seed ————%
   Canada
2. Germination————% Hard seed————% Live seed (Approx.)———— %
   Texas

III Group—*Germination percentage inclusive of hard seed percentage stated in report, and then hard seed percentage stated separately* 4

1. Germination————% Inclusive of hard seed————%
   Nebraska
   Wyoming
2. Germination (Including————% Hard seed)————%
   Arkansas
   New Hampshire

IV Group—*Hard seed percentage included in germination percentage as stated in report: hard seed percentage not stated separately* 1

1. Hard seeds counted as germinated.
   Tennessee

[1]The U. S. Department of Agriculture has a special report form which is used when the purity percentage is approximated and separate detailed reports are not made. This report shows (1) pure seed (approximate), (2) germination, (3) hard seed, (4) live seed, and (5) live pure seed (approximate).

section as shown in Table 2. Section 2 consists of the Illinois laboratory and reports actual sprouts——%, hard seed——%, and dead seed——%. Section 3, which consists of the Iowa State Department laboratory, reports germination——%, hard seed——%, and dead seed——%. Section 4, which consists of Pennsylvania, reports germination——%, hard seed——%, and a space is provided for "Total live seed——%", but the total is omitted in

reporting. Section 5, consisting of Washington, reports germination——%, weak sprouts——%, and hard seeds——%. Section 6, which consists of Nevada, reports normal germination——%, weak sprouts——%, hard seeds——%, and decayed seeds——%. Section 7, which consists of Utah, reports strong sprouts——%, hard seeds——%, weak sprouts——%, and dead seed——%.

Group II has been divided into two sections. Section 1, which consists of the Canadian laboratories, reports germination——%, hard seed——%, and, as a supplementary statement, germination plus hard seed——%. Section 2, consisting of Texas, reports germination——%, hard seed——%, and live seed (approx.)——%.

Group III consists of two sections. Section 1 reports germination——% inclusive of hard seed——% and includes Nebraska and Wyoming. Section 2, consisting of Arkansas and New Hampshire, reports germination (including——% hard seed)——%. In both of these section, the actual germination is obtained by subtracting the hard seeds from the germination as given.

Group IV consists of but the one state of Tennessee. In this state the hard seeds are reported as germinated and are not stated separately.

HARD SEED PROBLEM AS VIEWED IN SOME STATES

Comments on the present status of the hard seed problem were received with the laws and laboratory report forms from a number of the states. Some of these are rather significant and are given here.

The hard seed content of alfalfa is lower in Arizona than in the northern states. Such seed is not scarified unless it is shipped into other states. The Idaho Grimm Alfalfa Seed Growers' Association at Blackfoot, Idaho, scarifies all seed at the time that shipment is made. Enquiry of a number of alfalfa seed producers in Montana, who had seed tested which showed rather high percentages of hard seeds, indicated that in no case were unsatisfactory stands obtained.

In Kentucky, there is some sentiment among seed dealers to combine hard seeds with germination, but seed control officials and quite a few seedsmen are of the opinion that the two should be listed separately. In Louisiana, the officials of the seed testing laboratory are frequently asked to explain what is meant by "germination" and "hard seeds". It is considered that hard seeds are possibly going through a rest period. In Minnesota and Illinois, dealers desire to be permitted to add the hard seeds to the germination. In Rhode Island, people are occasionally interested in having "Total live seed" given on the label in addition to the statement of germination and hard seeds, but it is believed by officials to be a minor point.

The hard seeds are included with the germination in the states of Tennessee and Wyoming. No complaints on this system have been made. Officials state that they could not have legal alfalfa or clover in Wyoming without adding the hard seeds, as the law requires 85% germination in these seeds.

In Canada, where the germination and hard seeds are given separately and then stated as a sum on the laboratory report form, officials feel that the results of experimental work justify this practice. The minimum germination requirements of Canadian alfalfa grades would seem to require a system of this kind.

REPORT OF THE COMMITTEE ON INTERSTATE LABELING

This committee was requested to give consideration to a Federal statute that would require the labeling of seeds in interstate commerce. This consideration was no doubt requested in order to obtain an opinion as to whether such a statute would accomplish more adequate seed control than does the existing Federal statute.

It is the opinion of this committee that the prime motive of seed control is to make it possible for the consumer of seed to make intelligent purchases and be relieved of the experience that results from the use of unwanted, inferior, or unadapted seed. In order to accomplish this, it is of course necessary that certain responsibilities be assumed by the producer and the dealer as well as the analyst.

The attempt at this control took its original form in this country in the passage of State seed laws that required seed to be labeled. The passage of these laws, in addition to the State inspection systems that were being established, was depended upon to effect adequate control of seed in interstate commerce. The present interstate clause of the Federal Seed Act, in view of this, does not contain provisions requiring labeling in interstate commerce, but does require that the container, invoice, or advertising shall bear or contain no false and fraudulent statement, design, or device.

There has developed, principally by the dealers in so-called bargain seed and truck operators, the practice of shipping unlabeled or only partially labeled seed in interstate commerce. This seed is often unfit for seeding purposes and is usually sold as a result of misleading representations by catalog or word of mouth. This traffic is difficult to control because the seed is not offered to the consumer through the ordinary trade channels. In view of the difficulty in controlling this traffic, it is not believed that compulsory labeling in interstate commerce will entirely solve the problem. It is believed, however, that compulsory labeling in interstate commerce would tend to establish more uniformity in the interpretation of terms contained on labels in the several States, and would render assistance in the control of inferior seed passing in interstate commerce. Therefore, it is the opinion of this committee that this Association should go on record as recommending that there be a Federal statute requiring the labeling of seeds in interstate commerce.

This may be brought about in one of two ways:

1. Requiring a minimum label on all seeds passing in interstate commerce;
2. Prohibiting movement in interstate commerce of seeds not saleable in the destination state.

If a minimum label is adopted, it appears logical to adopt the labeling recommended in the Uniform State Seed Bill, which this Association and the seed trade have supported for so many years and which has served as a guide for the seed laws in most States. There are a few difficulties that become involved in the adoption of this labeling to a Federal statute, chiefly in regard to the treatment of noxious weed seeds. All requirements as to labeling, with the exception of this, could be universally adopted. Weeds are noxious in the several States as a result of climatic and soil conditions existing in those States. In the administration of the present Federal Seed Act it has been the practice to construe the word "noxious weeds" in the

light of the law or regulations in the State into which the seed is shipped for presumed sale to consumers. There is, however, no universal understanding as to what constitutes a noxious weed. The action of the many States in regard to this matter leaves the impression that plants which have become unduly prevalent are in some States considered noxious, while in other States, seeds which are rare but which are considered to be difficult to control are the type considered noxious. One State has 41 weeds listed as being noxious. Other States have approximately seven in number, which conforms to the recommendations in the Uniform State Seed Bill. It may be essential to leave the determination of noxious weed seeds to the discretion of the Secretary of Agriculture under a Federal statute. This appears to be a matter that warrants careful consideration by this Association.

Of increasing importance in recent years is the question as to what is the proper construction of the date of test in connection with the germination percentages shown on seed labels. In the ordinary course of business, the seller's representations are construed to apply at the time of the attempted sale. The wording of the labels on seed, however, has been at times construed in a different light, based on the assumption that it is impossible for the dealer at any one time to know the viability of the seed. It must be recognized that it takes time to determine the germination percenage of seed and that it would be placing an undue burden on the seed trade to expect them to be continually testing seeds to have the latest possible information as to its viability. There is need for considerable information with respect to the behavior of seed under varied storage conditions. It is the belief, however, that members of the trade are in a position to know the germination of their seed for a reasonable period of time following their last germination test. Unusual changes in viability are usually due to storage conditions which can be known or controlled only by the person in possession of the seed. The responsibility for these conditions or the loss due to these conditions can not fairly be passed to another. It has been suggested at times that buyers of seed should insist on a date of test not more than two or three months prior to the date of purchase. This matter has been discussed before the Association and is involved in the consideration of the proposed Uniform State Vegetable Seed Law. It is essential that this Association consider this matter carefully and arrive at a conclusion as to its point of view. It is the feeling of this committee that the seller should be responsible for the condition of the seed on the date of delivery to the purchaser regardless of the date of test. This is not to be construed to mean that the wholesaler is responsible for the condition of the seed on the date the retailer sells to the consumer. The retailer in this instance is the seller, regardless of whose name appears upon the container of the seed.

The matter of vegetable seeds is also involved in that it is not yet determined whether or not the States in general will approve of the type of labeling based on standards of germination, which is now under consideration by this Association. It is the opinion of this committee that the nature of a Federal statute as it applies to vegetable seeds should be determined by this development. It is the recommendation of this committee, however, that vegetable seeds in amounts of eight ounces or more should be completely labeled in accordance with the recommendations in the Uniform State Seed Bill, and that seeds in packets of less than eight ounces in weight should be labeled as to germination when they fall below certain

standards, to be determined by the Secretary of Agriculture, otherwise labeled in such a manner as to indicate they comply with those standards.

The responsibilities assumed by the factions involved must be apportioned in such a manner that unfair burden will be assumed by none. This Association should assume the responsibility of establishing methods of testing that would bring about truthfulness and uniformity in the results of tests. Seed analysts should assume the responsibility of testing seeds according to these methods. It is impossible for the seed analyst, whether he be official or employed by the dealer, to assume the responsibility for the degree in which any sample represents a lot of seed. This must be assumed by the dealer, for it is his responsibility that the seed be bulked in such a manner that it can be properly sampled. Careful consideration must be given to proposals that would place upon official seed analysts and their colleagues employed by the trade, responsibilities which in every other industry are assumed by the seller. There is nothing pertaining to the sampling or testing of seeds that would make this shift of burden justified. It is the recommendation of this committee that the dealer in seeds be responsible for the representations as to quality and that it is his burden to see that the analyst is furnished with a sample that represents the lot of seed to be labeled. It is the seed analyst's responsibility to see that the seedsman is provided with a statement showing the results of the test and the limitations, if there are any, in determining the facts regarding the sample.

One of the problems involved in compulsory labeling in interstate commerce is the question as to the nature of the inspection system that would be required. It is the recommendation of this committee that in view of the development of seed inspection in the several States and the manner in which the interstate clause of the present Federal Seed Act has been administered, that the detailed inspection should be that carried on by State employees and that this should be supplemented by Federal employees only in those instances where Federal assistance is necessary in establishing the facts in what appear to be violations of the Act. In this manner the extent of control in the different States will rest upon the activities of the officials within the State, whose activities are presumed to be subject to the wishes of the residents of the State. This would result in economical control and avoid undue duplication of inspection.—E. BROWN, *Chairman.*

REPORT OF THE CERTIFIED LABEL PLAN COMMITTEE

In keeping with the action taken at the last annual meeting, this committee on the Certified Label Plan submitted to the members of this Association a questionnaire relative to the various features of the plan. This plan, which has been proposed by the Division of Hay, Feed, and Seeds, Bureau of Agricultural Economics, U. S. Department of Agriculture, provides for certain features in the seed control work, among which are the following:

1. Licensing of state, commercial, and private seed analysts by the Hay, Seed, and Grain Division, and authorizing them to issue official certificates of inspection on seed offered for sale.
2. Licensing official samplers to take official samples for inspection.
3. Establishment of control laboratory and board of review.
4. Standardization of laboratory equipment and procedure.

5. Supervision of analysts by travelling supervising analysts, and checking of control samples by central control laboratory.

6. It has been proposed that the administration of these services be placed in the Hay, Feed, and Seed Division of the Bureau of Agricultural Economics.

A large majority of the 39 members of the Association who made reply were not in favor of this plan. The replies received from the questionnaire were submitted to the Secretary of the U. S. Department of Agriculture, as provided for by the Association a year ago.—A. L. STONE, *Chairman.*

REPORT OF THE LEGISLATIVE COMMITTEE

The major work of the committee this year has had to do with the Uniform State Vegetable Seed Law. This has received considerable attention from all of the members of the committee. The other phases of committee work which have received special attention by committee members are as follows:

1. Germination Standards of Vegetable Seeds—T. W. L. Burke.
2. Regulations under State Seed Laws—G. T. French.
3. Compiling of State Seed Laws—W. O. Whitcomb.

In the absence of Mr. Burke, the paper on Germination Standards of Vegetable Seeds will be presented by Mr. McIntyre.

The subject of Regulations under State Seed Laws will not be presented at this time as it is felt by the committee that this subject should receive further consideration. It is recommended that the incoming committee give this subject careful consideration and bring in a report at the next meeting.

The report on the compiling of the State Seed Laws will be presented by Mr. Whitcomb.

Copies of H. R. Bill 8288 have been supplied by Mr. Joseph F. Cox, a member of a Seed Committee of the U. S. Department of Agriculture. The title of this bill is "A Bill to regulate interstate and foreign commerce in certain seeds; to prevent misbranding, false advertising, and adulteration of certain seeds; to require certain standards with respect to origin, adaptability, purity, and germination of certain seeds; and for other purposes". Those wishing copies of this bill may obtain them at the Secretary's desk.

REPORT ON UNIFORM STATE VEGETABLE SEED LAW

At the last annual meeting, this committee presented a form of Vegetable Seed Law which, after consideration in open session, failed to meet, in all details, the approval of the Association. It also developed that there were certain points, in this proposed law, to which the Legislative Committee of the American Seed Trade Association raised objection. With these points in mind, this committee recommended that the law be referred back to them for further consideration.

The past year has been spent in a careful consideration of the various features of the law. In this consideration, the members of the Association have been given a voice and we have endeavored to receive suggestions from the trade and especially from recognized committees. The result is that we have a law to propose which we feel will meet the needs of the several states adequately for vegetable seed legislation. We believe that this form can create no unfair advantage to any one.

Mimeographed copies of this vegetable seed law have been placed in your hands.

The Committee wishes to recommend that the reports as presented be adopted by the Association.

A copy of this law as adopted is attached to this report.—L. N. ALLEN, *Chairman.*

UNIFORM STATE VEGETABLE SEED LAW

Adopted by the Association of Official Seed Analysts of North America in assembly in Washington, D. C., August 23–26, 1937.

TITLE

An act to regulate the selling, offering or exposing for sale of Vegetable Seeds, and to repeal all laws and parts of laws in conflict with this act.

Be it enacted by the Senate and House of Representatives:

(Note: Title and enactment clause should be worded in accordance with the requirements of the separate States. If a field seed law exists which is consistent with the provisions herein, it may be amended to include Vegetable Seeds with separate definition and label requirements.)

SECTION 1. DEFINITION OF VEGETABLE SEEDS.

The term "Vegetable Seeds", as used in this act, shall include the seeds of those crops that are usually grown in (name of State) in gardens or on truck farms and generally known and sold under the name of "Vegetable Seeds".

SECTION 2. LABEL REQUIREMENTS.

Each separate container of vegetable seeds sold, offered or exposed for sale within this State for seeding purposes, except as herein otherwise provided, shall be clearly, plainly, and truthfully labeled in the English language to show:

A. For containers of eight ounces or more in weight; and for containers of less than eight ounces in weight when the seed germinates less than the standard recommended by the Association of Official Seed Analysts of North America:

(1) The kind and the variety of seed.
(2) The approximate percentage of germination.
(3) The month and year said seed was tested.
(4) The full name and address of the person, partnership, association, or corporation, responsible for the labeling on said container.

B. For containers of less than eight ounces in weight when the seed germinates equal to or above the standard recommended by the Association of Official Seed Analysts of North America:

(1) The kind and the variety of seed.
(2) The statement "Germination equal to or above Association of Official Seed Analysts standard for—(year)," with the year inserted in each instance, provided the abbreviation "A.O.S.A." may be used in lieu of "Association of Official Seed Analysts".

(3) The full name and address of the person, partnership, association, or corporation responsible for the labeling on said container.

SECTION 3. EXEMPTIONS.

Vegetable seeds shall be exempt from the provisions of *Section 2* of this act:

(a) When sold, offered or exposed for sale for food purposes only.
(b) When sold or offered for sale to be re-cleaned before being sold, offered or exposed for sale for seeding purposes.
(c) When sold for seeding purposes, if delivered directly to the purchaser by the grower on the same premises where grown. If, however, said seed be advertised for sale through any medium it shall be subject to the provisions of Section 2 of this act.

SECTION 4. VIOLATIONS.

(a) It shall be unlawful to sell, offer or expose for sale within this State for seeding purposes:
  (1) any vegetable seeds not labeled in accordance with the provisions of Section 2 of this act, or
  (2) any vegetable seeds otherwise falsely or fraudulently labeled or represented.
(b) It shall be unlawful to obstruct or hinder the State Seed Commissioner or his agents in the discharge of their duties under this act.
(c) Every violation of the provisions of this act shall be deemed a misdemeanor punishable by a fine not exceeding one hundred dollars and not less than ten dollars.
(d) It shall be construed that the seller is responsible under this act for the condition of the seed on the date of delivery to the purchaser, regardless of the date of test.

SECTION 5. DUTIES AND POWERS OF THE STATE SEED COMMISSIONER.

(a) It shall be the duty of the State Seed Commissioner, who may act through his authorized agents, to:
  (1) investigate, inspect and sample vegetable seeds sold, offered or exposed for sale within this State for seeding purposes, at such time and place and to such extent as may be necessary;
  (2) determine by analysis, test, examination, or field trial in so far as it is practicable whether or not said vegetable seeds are in violation of any of the provisions of this act;
  (3) in his discretion publish or cause to be published the results of the analysis, test, examination, or field trial on any vegetable seed found to be in violation of any of the provisions of this act, together with the name and address of the person, partnership, association, or corporation, appearing on the label, and the name and address of the person, partnership, association, or corporation, who offered or exposed the seed for sale;
  (4) prescribe, and after due notice to the seed trade, adopt such regulations as may be necessary to secure the efficient enforcement of this act.

(b) The State Seed Commissioner shall be guided in the performance of his duties under this section by the Rules and Recommendations for Testing Seed adopted by the Association of Official Seed Analysts of North America.

(c) In case a sample of vegetable seed obtained under the provisions of this act is found to be in violation of any of the provisions of this act, the person, partnership, association, or corporation, who sold, offered or exposed the seed for sale shall be notified and a copy of said notice shall be mailed to the person, partnership, association, or corporation, responsible for the labeling of the container of said vegetable seed.

(d) The State Seed Commissioner is hereby authorized to purchase, and to pay a reasonable market price for such samples of vegetable seeds as may be necessary to carry out the provisions of this section.

(e) The State Seed Commissioner and his authorized agents are empowered with authority to enter upon any public or private premises for the purpose of carrying out the provisions of this act.

(f) The State Seed Commissioner and his authorized agents may issue written "stop sale" orders which shall prohibit further sale of any lot of vegetable seeds found to be in violation of any of the provisions of this act until the law has been complied with or said violation otherwise legally disposed of.

(g) For the purpose of carrying out the provisions of this act the State Seed Commissioner is authorized to establish and maintain trial grounds and a seed laboratory with the necessary equipment; to employ experts and incur such expense as may be necessary to comply with these provisions.

SECTION 6. SEIZURE.

Upon the recommendation of the State Seed Commissioner or his duly authorized agents, the county court of the county in which the seed is located shall cause the seizure and subsequent denaturing, processing, or destruction to prevent the use for seeding purposes of any lot of vegetable seed found to be unfit for seeding purposes; provided that in no instance shall the denaturing, processing, or destruction be ordered without first having given the claimant of said seed an opportunity to apply to said Court for the release of said seed.

SECTION 7. PROSECUTIONS.

When the State Seed Commissioner shall find upon analysis, test, examination, or field trial that any person, partnership, association, or corporation, has violated any of the provisions of this act, he or his duly authorized agent or agents may institute proceedings in the county court of the county in which the violation occurred, to have such person, partnership, association, or corporation, convicted therefor; or the State Seed Commissioner, in his discretion, may report the results of such analysis, test, examination, or field trial to the Attorney General, together with sworn statement of the analyst duly acknowledged, and such other evidence as may be deemed necessary; provided however that no prosecution under this act shall be instituted without first having given the defendant an opportunity to go

before the State Seed Commissioner or his duly authorized agent to introduce evidence either in person or by agent or attorney at a private hearing. If, after such hearing, or without such hearing in case the defendant or his agent or attorney fails or refuses to appear, the State Seed Commissioner decides the evidence warrants prosecution, he shall proceed as herein provided.

It shall be the duty of the county prosecuting attorney or the Attorney General, as the case may be, to institute proceedings at once against the person, partnership, association, or corporation, charged with such violation.

SECTION 8. FREE TESTS AND FEES FOR TESTING.

Any citizen of this State shall have the privilege of submitting to the State Seed Commissioner samples of vegetable seeds for test and analysis, subject to such regulations as may be adopted by said Commissioner. Provided that the Seed Commissioner may by such regulations fix the maximum number of samples that may be tested free of charge and for any one citizen in any one period of time and fix charges for tests of samples submitted in excess of those tested free of charge.

SECTION 9. APPROPRIATIONS.

(Each State shall make its provisions for appropriations and expenditures of funds according to local requirements).

SECTION 10.

Chapter .....of the laws of.....and any other laws or parts of laws in conflict with this act, are hereby repealed.

SECTION 11.

This act shall be effective on and after .....

GERMINATION STANDARDS FOR VEGETABLE SEEDS

T. W. L. BURKE

For the Legislative Committee

It is the intent of this committee that the standards for germination of vegetable seeds that may be recommended by this Association will be arrived at after due consideration has been given to such recommendations as members of the trade, or committees of their organization, may care to make.

As a basis on which to formulate standards of germination for vegetable seeds, a questionnaire was sent to the member laboratories of the Association to obtain information as to present practices. The replies from 40 laboratories indicate that 19 states now have no laws dealing with vegetable seeds. These states are as follows:

California	Kansas	Pennsylvania
Colorado	Maine	Rhode Island
Delaware	Maryland	South Dakota
Georgia	Montana	Tennessee
Idaho	Nebraska	Vermont
Illinois	North Carolina	Wyoming
Iowa		

Of these states, Illinois and Montana are considering vegetable seed legislation.

TABLE 1.—*Standards for germination of vegetable seeds in use at present*[1]

Kind of Seed	Canada	Virginia	Washington	Wisconsin
	%	%	%	%
Artichoke	60	—	75	—
Asparagus	60	—	75	70
Beans (garden)	70	80	90	85
Beets (garden)	60	65	90	70
Brussels sprouts	70	75	75	75
Broccoli	60	75	75	—
	%	%	%	%
Cabbage	70	75	90	80
Cantaloupe	—	—	90	—
Caraway	—	—	75	70
Carrots	50	55	75	60
Cauliflower	70	75	90	75
Celeriac	55	—	75	60
Celery	55	60	75	60
Chard-Swiss	60	65	75	75
Chervil	60	—	75	—
Chicory	60	—	75	—
Chives	60	—	75	—
Citron	60	—	90	65
Collard	—	75	75	80
Corn (Sweet, Squaw)	70	75	75	70
Cress	60	—	75	75
Cucumber	70	80	90	80
Dill	—	—	75	60
Egg Plant	60	60	75	65
Endive	60	70	75	75
Kale or borecole	60	75	75	75
Kohl-rabi	70	75	75	80
Leeks	60	60	90	70
Lettuce	70	80	90	80
Mellon, musk	70	80	90	80
Melon, water	70	70	90	75
Mustard	60	75	75	80
Okra	—	50	75	70
Onion	70	70	90	75
Parsley	55	60	75	65
Parsnip	45	60	75	65
Peas (garden)	70	80	90	85
Pepper	55	60	75	60
Pumpkin	60	75	90	75
Radish	70	80	90	80
Rhubarb	—	—	75	65
Rutabaga (swede)	70	75	90	80
Sage	45	—	75	—
Salsify	60	75	75	70
Savory	45	—	75	—
Spinach	55	60	75	65
Spinach, N. Z.	—	—	75	—
Squash	70	75	90	80
Tomato	70	80	90	80
Turnip	70	80	90	85
Vegetable Marrow	60	—	90	—

1 1937 Standards.

COMPILATION OF FEDERAL AND STATE SEED LAWS

W. O. WHITCOMB
For the Legislative Committee

During the past few years there has been some talk of assembling all of the seed laws and making them available for distribution in some convenient form. More recently the seed laws have been assembled in connection with a study of the labeling requirements of hard seeds, so that they were made available for consideration as to possibility of publishing. These consist of the Federal seed laws of the United States and Canada and the state laws from 46 states.

Counts have been made of the number of lines, so that the space has been computed. This shows that there will be between 180 and 200 pages of single-spaced elite typewritten material. The cost of publishing 200 copies of these laws in mimeographed form on good paper in a loose leaf cover of good quality has been rather carefully determined and found to be between $165.00 and $200.00

The Legislative Committee would like to be authorized to publish these laws in this form with the idea of furnishing inserts or changes each year to keep the information up to date. It is the thought that these laws in this form can be sold at a price which will cover the cost of publication.

REPORT OF THE RESEARCH COMMITTEE

Objectives

1. To determine the amount of variation in purity analyses and germination tests as reported by different laboratories on similar sub-samples of seed.
2. To study some of the causes of extreme variations.
3. To compare two or more methods as measured by both accuracy and uniformity of results.
4. To assist analysts who have difficulty with certain kinds of seeds in improvement of technique.
5. To assist the sub-committee on rules in supplying additional information which might aid in rule revision.
6. To inquire into methods used by some analysts who seem to be especially skillful in obtaining germination of grasses.

Following the approval of the plan by the Association at the Rochester meeting in June, 1936, the states and provinces of the United States and Canada were grouped in such a manner as to constitute five regions, each with a regional chairman who is a member of the Research Committee. The regional chairmen for the past year were:

W. O. Whitcomb	— N. W. Region	No. 1
R. H. Porter	— N. Central Region	No. 2
C. W. Leggatt	— N. E. Region	No. 3
Anna M. Lute	— S. W. Region	No. 4
C. M. Bass	— S. E. Region	No. 5

Early in July, a letter was sent to each regional chairman suggesting certain problems but requesting that he outline and conduct any research or referee work in his region as he saw fit. One of the suggestions made was that a further study of sand as a medium for determining normal seedlings

be made, and further, that each referee sample be first studied by the referee and that directions for interpreting normal and abnormal seedlings be sent with the sample.

The report of the work for the year will be made by each regional chairman, for the Association as a whole by the committee chairman, and by the subcommittees on Rules and Handbook.

REGION NO. 1

W. O. WHITCOMB

Region No. 1 was composed of two provinces and eight states. The provinces were Alberta and Saskatchewan and the states were Washington, Oregon, Idaho, Wyoming, Montana, North Dakota, and South Dakota. Utah was included in this region by request of the analyst in charge of the laboratory.

Two commercial laboratories and the official laboratory of the U. S. Dept. of Agriculture at Washington, D. C. cooperated in the work on certain samples.

The work was begun by writing to each laboratory to learn their wishes as to the kinds of seeds and the type of tests which were desired for the year's study. Enquiry was also made as to what kinds of seeds each laboratory could furnish. Not all the laboratories were in a position to participate and some laboratories, because of routine testing, could do only a part of the work. Nine official laboratories and two commercial laboratories tested two or more of the 13 lots of seed which were supplied. The analysts were instructed to follow the Rules for Seed Testing as proposed by the Research Committee at the last annual meeting.

Several problems having to do with a variety of seeds were undertaken. The seed value of a sample of light weight wheat proved to be a rather difficult study. The variations in pure seed as well as the germination as determined by the various analysts was greater than should have been if all had been familiar with this type of material. The lack of agreement in germination results seemed to be due to a different viewpoint in what constituted strong and weak sprouts.

A study of the detection of the seeds of black medick in alfalfa proved to be an interesting one. Ten black medick seeds were placed in each sample as it was made up. The analysts were asked to report the number of black medick seeds found in the entire sample. The number reported ranged from 7 to 13. This indicated a lack of familiarity with this rather common impurity of alfalfa seed.

Two samples of vetch seed containing admixtures of other vetches were subjected to purity analysis by the various analysts. These samples were furnished by an analyst who was familiar with vetches and who furnished type samples of all the vetches which constituted the mixtures. One sample was common vetch (*Vicia sativa*) containing *V. pannonica* and *V. villosa,* while the other was hairy vetch (*Vicia villosa*) containing *V. Sativa, V. dasycarpa,* and *V. pannonica.* As some analysts were not familiar with the vetches, rather divergent results were obtained. However, most of them expressed themselves as being very much interested in this seed.

Two lots of sweet clover and two lots of flax from North Dakota which were tested for germination proved of special interest to all of the analysts.

These seeds were all of low germination, yet were typical of many of the samples being tested in that state. One of the sweet clovers was described by the North Dakota analyst as a "thin green seed difficult to judge as to viability", and the other was described as "having a stubby type of root rather difficult to classify." The germination results are shown in Table 1.

TABLE 1.—*Summary of referee tests Region No. 1 1936–37.*

Sample number	No. Labs.	Purity		Germination			
		Range	Mean	Blotters or towels		Sand or Soil	
				Range	Mean	Range	Mean
		%	%	%	%	%	%
1. Wheat	7	93.5–97.4	95.2	77–95	89	73–96	84
2. Barley	7	81.8–96.5	93.7	93–97	95	88–97	93
3. Alfalfa	7	99.0–99.6	99.4	76–88	83	77–86	80
4. Crested Wh. Grass	7	87.6–90.7	89.5	84–94	91	92–96	94
5. Common Vetch	9	66.9–76.3	69.1	74–93	85[1]	74–96	85[2]
6. Hairy Vetch	9	59.2–81.4	73.9	83–93	87[2]	84–94	86[3]
7. Sweet Clover	8	Not requested	....	2–13	9	3–17	7[4]
8. Sweet Clover	8	" "	....	38–49	44	36–44	41[4]
9. Flax	8	" "	....	45–62	55	0–3	1[5]
10. Flax	8	" "	....	30–43	37	1–2	1[5]
11. Millet	9	88.8–99.5	95.0	Not requested		.....	..
12. Millet	9	93.5–99.3	96.3	"	"	.....	..
13. Millet	9	95.8–99.6	97.8	.....	..	.....	..

[1]Eight laboratories.
[2]Seven laboratories.
[3]Six laboratories.
[4]Five laboratories.
[5]Three laboratories.

Three lots of millet seed which were submitted for a study as to type or trueness to variety proved to be the most interesting phase of the work in some respects. These millets consisted of the varieties Early Fortune, Siberian, and Hog. The analyst who furnished them has made a special study of millets in the laboratory and in the field and has supplied some evidence to show that there is crossing between varieties of millets in the field and also crossing between millet and green foxtail. The analysts in the region were requested to report the percentages which they considered true to variety in each lot, together with the name and percentages of other kinds of millets or crosses. Without going into detail concerning this study with millets, it may be said that there was a variety of opinions relative to varieties and types, but a general agreement that each variety as submitted contained an appreciable amount of off-type seed. It is apparent that all the analysts who worked on this problem and who studied the tabulated results of all the analysts, have learned a great deal about millets and how other analysts are inclined to handle them.

REFEREE TESTING — REGION NO. 2

R. H. PORTER

Ten states and one Canadian province comprised region No. 2, namely Kansas, Nebraska, Missouri, Iowa, Minnesota, Wisconsin, Michigan, Ohio, Indiana, Illinois, and Manitoba. In addition, California and Utah participated

in practically all of the tests and Nevada made the first two tests. A total of eight referee samples were sent, beginning in October. The last set was mailed in November. The samples were Bermuda grass, orchard grass, sorghum, domestic rye grass, rye, sweet clover, red clover, and soy beans. Practically 100% participation was the experience in this region, although a few laboratories were for one reason or another, late in sending reports. Six commercial laboratories in this region also participated in most of the tests.

Each kind of seed was tested by the method recommended in the rules for seed testing and, for comparison, a test was made in sand. The recommendations given for the use of sand were, (1) that clean river sand visibly free from organic matter and capable of passing a 16-mesh sieve be used, (2) that the sand be baked in an oven or over an electric plate for five hours, and (3), that a measured quantity of water be added to a given weight of sand, varying according to the kind of seed to be tested.

All data obtained in comparative germination tests and part of the data from purity analyses were statistically analyzed by the chi-square test for homogeneity from which probability of occurrence was computed. A probability below .05 was considered indicative of significant differences, that is to say, if the differences were great enough to give a probability below .05 it was considered that such results should not be expected among uniform subsamples from a homogeneous lot of seed and further that one or more of the causes for such variations might be, (1) non-uniform subsamples, (2) dissimilar conditions for germination in the several laboratories, and (3), errors in personal judgment as to what constitutes a normal seedling. A point which deserves mention is that the larger the chi-square the greater the variability of results, hence even though a chi-square value is sufficient to give a probability below .05 it is possible to measure the degree of variability and thus compare methods simply by determining and comparing chi-square values.

TABLE 4.—*Summary of referee tests region No. 21936–37.*

Sample No. and number laboratories testing	Purity		Germination			
	Range	Mean	Blotters, petri dish or towels		Sand	
			Range	Mean	Range	Mean
	%	%	%	%	%	%
1. Bermuda grass (20)	71.0–81.9	72.9	4–91	64.7	.....	..
2. Orchard grass (19)	82.7–99.0	91.4	7–86	74	.....	..
3. Red clover (17)	89.1–99.2	98.1	65–80	72	51–74	68
4. Sweet clover (17)	97.7–99.8	99.5	29–55	44	19–45	40
5. Rye grass (17)	98.8–99.7	99.3	83–99	94	55–97	87
6. Sorghum (19)	98.6–99.9	99.2	65–98	91	86–94	91
7. Soybeans (17)	98.2–99.6	99.1	70–93	85	71–95	84
8. Rye (16)	82.1–97.3	87.2	14–70	46	9–53	38

The data obtained by the several cooperating laboratories in region No. 2 are given in Table 4 but no chi-square or probability values are included. In most cases the differences in purity and germination were shown to be much greater than should be expected among uniform sub-

samples of seed from well mixed lots, however less variability was obtained in sand tests than in blotters for sweet clover, sorghum, and rye, no difference in variability was noted for red clover or soy beans and only for rye grass were the results more uniform with blotters than with sand. The data obtained from official laboratories showed less variability in sand tests than in blotters for red clover, sweet clover, sorghum, soy beans and rye. It should be recognized that most analysts have had less experience with sand than with blotters, hence the results are of interest and although not at all conclusive inasmuch as data for only one year have been obtained, yet they suggest that sand offers possibilities as a medium for interpreting normal and abnormal seedlings in a more uniform manner, especially for some of the legumes and cereals. Tests with sand as a laboratory medium should be continued over a long period of time.

REGION NO. 3

C. W. LEGGATT

Region No. 3 comprised the following official laboratories: Colorado, Delaware, Maine, Massachusetts, Montreal, Quebec, New Hampshire, New Jersey, New York, Ottawa, Pennsylvania, Sackville, N. B., Toronto, and Vermont.

Rhode Island reported that their seed analytical work was being done for the present by other official laboratories.

During the year, three commercial laboratories expressed the wish to be included in Region No. 3.

Before any samples were sent out, all laboratories were circularized to determine how they were equipped and when they would prefer to have referee samples sent, so that we might be guided both as to the type of work to be requested and as to the convenience of the laboratories. Unfortunately, in the latter point there was no unanimity, so samples were sent out when suitable ones came to hand. It was evident from the questionnaire that most laboratories were equipped to handle almost any test likely to be called for.

Seven samples were distributed as indicated in the remainder of this report. One other sample had been prepared for distribution, but unfortunately, when the time came to send it out it was found to have lost the peculiar behaviour which was the reason for its selection. This sample, oats, showed a marked difference between germination in sand and in blotters, the sand tests registered in the 90's with clean strong sprouts, while the blotter tests were about 70% with a large proportion of abnormal sprouts having a characteristic lesion on the epicotyl. This was in the fall of the year. In the spring, however, this difference had quite disappeared, and tests in blotters were just as good as they were in sand.

One of the main objects in mind was to see whether it was feasible to use some sort of standard soil or sand medium, and whether the same kind of medium could be used for a number of different kinds of seed. Hitherto, much has been done with soil tests, but these have one disadvantage, namely, that it has been found (particularly among European laboratories and probably to some extent among our own) that soil is difficult to work with and presents difficulties in sterilization, such as development of toxicity, which make the results uncertain. The sand test is intended to replace the soil test at least in the case of those laboratories which have had such diffi-

culties with soil, and to serve exactly the same function, namely, as a guide to the interpretation of abnormal sprouts and as a final "court of appeal" in the case of doubtful samples.

The Toronto Laboratory has done a considerable amount of work with sands, and has secured for the purpose of experimentation a limited amount of crushed quartz of different grades. Working principally with clovers, it was found that a mixture of 50:50 of grades of 28–48 and 60–100 (approximately) gave the best results, such a mixture having a good water-retaining capacity and, when mixed with the proper amount of water, working easily. However, it was very expensive to use, and accordingly the use of a river-washed sand supplied by a building supply house was tried, with which equally good results were obtained after it was sterilized. A physical analysis of this sand showed about 40% retained on a 48-mesh sieve and an additional 42% retained on a 100-mesh, so that it was not far removed from the artificial mixture we had developed. This suggested that any sand of approximately this composition and free of any appreciable quantity of organic matter would prove as satisfactory. Accordingly, small samples were distributed to cooperating laboratories with a statement of physical analysis. Most laboratories seemed to have little difficulty in securing similar material.

The first two samples were both sweet clover seed, of different germinating capacities. Six laboratories sent in results in time to be summarized.

Each station appeared to have secured a satisfactory sand. It should be said that with sand of the composition described, the optimum moisture content for clovers is 6 to 6.5%. Differences between the means of blotter and sand tests were not statistically significant. Indices of variability were calculated for normal and abnormal sprouts and for hard seeds. The latter are of such a nature that there is no question as to their interpretation; nor is any appreciable experimental error introduced in their case, owing to slight differences in germination conditions. That is, we are dealing only with sampling error. This sampling error is to be considered as of theoretical magnitude when the index of variability equals 1, as was practically the case with hard seeds.

When errors of interpretation were introduced, however, as was the case with normal and abnormal sprouts, the situation was different. In all cases the I. V. for normal sprouts was less than unity, and for abnormal sprouts greater than unity. That is, the normal sprouts showed less variation than would be expected from sampling error and the abnormal sprouts more. This points to a conscious or unconscious effort to interpret one test in relation to its mates and not as an independent test. In other words, the first test counted is the "leader", as it were, and the others are made to conform as closely as possible to it. This, in a mild degree, is an undesirable tendency since it offsets the value of random sampling and may tend to fix an error of judgment made in the first test counted, and on the whole it will tend to increase the variability between laboratories. As the variability in normal sprouts was reduced by slight errors in interpretation, the excess variability, so to speak, has been thrown into the abnormal group with corresponding increase in the indices for that group. The interpretation of abnormal sprouts was far from uniform.

The I. V. for sand was more nearly theoretical than for blotters in both samples.

Referee samples Nos. 3 and 4, onion, represented a continuation of the study of sand as a standard medium. Of the two samples sent out, the first was of low, the other of high germination. Both samples, especially No. 3, showed some mould in preliminary tests, so the request was made that laboratories surface-sterilize the samples and report on the method of sterilization. This was done to see how the different stations would accomplish it, but the result was a little unfortunate from the point of view of interpretation, since it was impossible to estimate how much variation was introduced on this account.

The tests were conducted with sand of two moisture percentages, namely, 6% and 7.5%. Blotter tests also were made. Ten laboratories cooperated in testing these samples.

The request was made that tests should be randomized for the wet count, so that no test should be influenced by previous counts on the same sample by the same method.

In the low germinating sample, the blotter tests gave significantly higher results (7%) than the sand tests, but the variability of the latter was less, though it was not possible to demonstrate the significance of this. The I. V.'s were 1.89, 1.68 and 1.46 for the B.B. tests and for sand tests with 6% moisture and 7.5% moisture respectively. The abnormal sprouts showed extreme variability.

In the high germinating sample, the means of all methods were very close, and no significant differences appeared. The I. V. for 7.5% moisture sand was quite low, 1.26.

It is evident, then, that the sands used in these tests were suitable media for onions, and that the samples of onion used were not sensitive to moisture within the range employed. Abnormal sprouts in onion require further study.

Referee Sample No. 5 was issued to determine whether sand has any advantage as an aid in interpretation of weak sprouts in beet seed. It is, unfortunately, a difficult medium to use for *Beta* spp. when it is desired to determine the number of sprouted balls, but if it has any advantage it should become evident in a comparison of sprouts produced in sand and between blotters; hence in this test, only sprouts were counted except in the blotter tests. Nine stations took part in this test.

Extreme variations occurred both in germinated balls and in sprouts, in sand as well as in blotters. Germinated balls varied from 56.5 to 81.3%, sprouts in blotters from 106.3 to 157.0 and in sand from 115.0 to 152.5. Thus the sand showed slightly more uniformity than the blotters, and it averaged 11 more sprouts per 100 balls—a significant difference. Abnormal sprouts varied from 4.3 to 51.5 in blotters, and from 0 to 16.5 in sand.

Purity analyses were called for and the results of these indicated that the sample was adequately mixed before distribution, so these variations must be attributed to differing judgment and technique.

As a result of this experience with Sample No. 5, it was felt advisable to concentrate on ordinary germination of *Beta* spp. With this in view, large samples of mangel No. 6 and beet No. 7 were issued, with the request to separate a 50 gram sample by means of 5, 4, 3 and 2 mm. sieves, and to germinate each portion separately. At the same time a regular test series was to be counted from the balance of the sample.

At the time of writing this report, seven laboratories have participated and are included in the analysis to follow. Several laboratories had difficulty

in securing the proper sieves, and one of these in consequence reported only by the regular method.

Definite significance could not be attached to any of the results secured, but with both samples the modified method gave a lower standard deviation than did the regular method, which is at least suggestive. The I. V. could not be calculated for the special method, owing to the manner in which the results were computed, but with the regular method it was extremely high, 4.44, showing that considerable amount of work must yet be done on the germination of *Beta* spp.

TABLE 2.—*Summary of referee tests—Region No. 3 1936–37.*

Sample number	No. Labs.	Purity		Germination			
		Range	Mean	Blotters		Sand	
				Range	Mean	Range	Mean
		%	%	%	%	%	%
1. Sweet Clover	6	Not asked	....	63–70	66	65–72	68
2. Sweet Clover	6	" "	....	51–57	53	46–56	52
3. Onion 6%	10	" "	....	22–48	34	20–39	27
4. Onion 6%	10	" "	....	84–95	89	86–94	90
5. Beet[1]	9	92.8–100.0	95.5	105–157	124	115–153	134
6. Mangel	6	Not asked	....	73–96	88	(77–91	83)[2]
7. Beet	6	" "	....	71–82	78	(70–81	77)[2]
3. Onion 7.5%	..	.....	....	.....	...	17–33	26
4. Onion 7.5%	..	.....	....	.....	...	82–92	87

[1]Sprouts reported in this table, Sample 5.
[2]Special Method, not Sand.

Table 2 presents a summary of the Referee work in Region No. 3 during 1936–37.

In conclusion, I should like to thank the participating laboratories for their cooperation and for many useful and interesting comments made as the work progressed. I regret that I was unable to send out as many samples as I had hoped or samples which were, perhaps, of more interest to some of our members. I feel that what we have done has shown the usefulness of sand of suitable composition as a medium for the germination of some kinds of seed, and I believe there is little doubt that it will be found applicable to many others. We have also exposed certain weaknesses in our germination methods and indicated where further research may profitably be done.

REGION NO. 4

The laboratories in California, Utah, Nevada, Arizona, New Mexico, Colorado, Texas, and Oklahoma were circularized and it was found that only four were in a position to participate, hence it was decided that no referee work should be undertaken as a separate region. New Mexico and Arizona carry on but little service testing and have no facilities at present for active participation in referee testing. Texas and Oklahoma found it impossible to take part, hence all samples prepared for region No. 2 were sent to California, Utah and Nevada. Colorado joined with region No. 3 and Utah did some of the tests in regions No. 1 and No. 2.

REFEREE TESTING — REGION NO. 5

C. M. BASS

Two samples were sent out, namely sweet clover and Bermuda grass; they were the same samples used in region No. 2. Four laboratories, Maryland, Arkansas, Virginia, and West Virginia participated. A summary of the results obtained are shown in Table 3.

TABLE 3.—*Summary of referee tests in Region No. 5. 1936–37.*

Laboratory	Bermuda Grass		Sweet Clover		
	Purity	Germination	Purity	Germination	
				Blotters	Sand
	%	%	%	%	%
1	73.7	90	99.7	45	41
2	71.7	85	99.7	36	31
3	75.8	88	99.9	41	44
4	73.9	75	99.7	42	41
Mean	73.8	84	99.7	41	39

The results show close agreement for purity of sweet clover and fair agreement for purity of Bermuda grass, especially since the sample contained considerable shriveled alfalfa seed. Germination of Bermuda grass was fairly uniform, except for laboratory No. 3, for which the variation was greater than should be expected from uniform sub-samples of seed. Three laboratories obtained reasonably uniform results in the germination of sweet clover in both blotters and sand. The difference in means for sand and blotters was not significant. It is probable that laboratory No. 2 was a bit too severe in reading the test because with the same sample, 17 laboratories in region No. 3 obtained a mean of 43.4%.

REFEREE TESTS FOR THE ASSOCIATION AS A WHOLE

The referee work for the association as a whole consisted of tests by different laboratories on samples of blue grass, sorghum, and lima beans. Two samples of blue grass representing high and low purities were sent. The results obtained are shown in Table 5. A study of these data indicates that, (1) such differences should not be obtained from sub-samples of a homogeneous lot, and (2), the modified method gave narrower differences for the low purity sample in extremes of purity than did the official method. In addition, the time required for a test by the modified method was ½ to ⅗ as long as by the official method. Data obtained by five commercial analysts are similar to those from official laboratories.

A third sample of blue grass was sent to ten laboratories, including the Iowa laboratory. Each sub-sample was first blown, the two portions recombined and sent to the respective laboratories with the request that the blowing be the same as used by the referee and analysis made by the modified method. The results obtained by eight laboratories that reported

TABLE 5.—*Blue grass referee tests: Comparison of purity and of germination results by official and modified methods—Average of 26 laboratories.*

Sample No.	Purity		Germination	
	Range	Mean	Range	Mean
	%	%	%	%
Official Method				
1	60.5–82.0	73.1	52–87	80
2	90.9–96.0	94.5	61–91	90
Modified Method				
1	67.5–78.4	76.4	53–86	70
2	91.5–98.0	96.1	64–92	89

were remarkably uniform as to purity as shown by the following values for the means:

Weight 1.227 g.; heavy 85.98% purity 83.43%; Chi-square 12.9%; Probability 0.08; and differences in extremes 1.87.

It is believed that never before in the history of the Association have there been such uniform results in purity analyses of blue grass.

The differences in germination, however, were more variable than the differences in purity, but germination on top of sand was less variable than on filter papers, as shown by the following data:

Method	*Range %*	*Mean %*	X^2	*Probability*
Top of blotter petri dish H_2O	66–87	78	74.6	< .01
Top of blotter petri dish KNO_3	61–84	76	81.0	< .01
Top of sand petri dish	71–86	79	38.5	< .01

Further study of a more uniform procedure in making tests with blue grass should be continued.

TEST WITH LIMA BEANS

In cooperation with a commercial Laboratory and a seed company in California, two samples each of Henderson Bush and Fordhook lima beans were sent to eight laboratories for test in the laboratory, greenhouse, and field. Complete returns were not available at the time this report was prepared, but data supplied by six laboratories show wide differences in field and laboratory tests in towels. In sand, however, either in the laboratory or greenhouse, fairly close agreement was obtained.

TESTS WITH SORGHUM

One seed company requested that a study be made of sorghum germination. Three samples were obtained and three laboratories cooperated;—a state laboratory and two commercial laboratories. The results are given below:

Sample No.	Blotters		Sand	
	Range	Mean	Range	Mean
	%	%	%	%
1	61–70	61	57–69	62
2	65–74	70	60–71	61
3	72–81	78	51–80	69

Two laboratories obtained similar results in both blotters and sand but one reported significantly lower results with sand. Further experience should decrease the differences.

MISCELLANEOUS TESTS

Several seedsmen and official laboratories requested assistance in making tests of soy beans, blue grass, alsike clover, canary grass, millet, onions, and rape. Tests were made and reported, and so far as known, the problems were solved.

ANALYSIS OF IDENTICAL SAMPLES BY TWO OFFICIAL LABORATORIES

Five samples of red clover were selected and analyzed by the Iowa Laboratory, after which all of the component parts of each were returned to a separate envelope, carefully sealed and mailed to the Ottawa laboratory together with sealed reports of the purity analyses which were not examined until the purity determinations had been completed by Ottawa. The Ottawa laboratory then divided the pure seed from each sample, sent one-half to Iowa and retained the other half. Germination tests were conducted between blotters and in sand. Later, the Ottawa laboratory selected five samples of alfalfa and followed the same procedure as described for red clover. The results of these cooperative tests are shown in Table 6.

TABLE 6.—*Comparison of purity and of germination of red clover and alfalfa by the Iowa and Ottawa laboratories.*

Sample No.	Purity		Germination			
			Blotters		Sand	
	Iowa	Ottawa	Iowa	Ottawa	Iowa	Ottawa
	%	%	%	%	%	%
Red Clover						
1	98.6	98.4	89	85	86	88
2	96.3	96.2	83	84	81	79
3	90.5	90.2	87	85	89	84
4	97.5	97.6	87	83	82	76
5	99.6	99.2	82	80	82	80
Mean	....	....	86	83	84	79
Alfalfa						
1	99.4	99.6	64	65	62	63
2	99.5	99.4	56	57	58	55
3	99.2	99.2	47	54	47	49
4	97.8	97.8	62	59	56	56
5	95.8	95.7	76	74	78	77
Mean	....	....	61	62	60	60

The data for the most part show (1) close agreement as to purity, (2) excellent agreement in both sand and blotters for the alfalfa, and (3) good agreement on the germination of the red clover. It is suggested that other laboratories conduct cooperative tests of this type.

COOPERATION WITH THE SEED TRADE

In the past, considerable attention has been given by both the legislative and research committees of this Association to cooperative relationships with the Commercial Analysts and the Seed Trade. Early in 1936, a definite attempt was made by the present chairman of the research committee to contact representatives and committees of the Seed Trade Association to learn more of their problems and to find out how our research committee could contribute to the solution of some of our mutual problems. In December 1936, the chairman of the Farm Seed Group, together with two members of the committee on seed testing of the Farm Seed Group, came to the Iowa laboratory and spent several hours discussing common problems. Constructive suggestions were made for the solution of our problems. An invitation was extended to the head of the Iowa Laboratory to speak before the Seed Trade Group in Chicago in January 1937, which was accepted. The manner in which the remarks were received afforded additional conviction of the desire on the part of seedsmen for friendly and cooperative relations between the Seed Trade and Official Analysts.

RECOMMENDATIONS

On the basis of experience the past two years, the Research Committee wishes to make the following recommendations relative to the work of the future:

1. That regional referee work be continued on a restricted basis, such that referee tests be limited to those kinds of seeds which offer problems either of peculiar or primary interest to the region concerned.

2. That each regional chairman assume the responsibility for determining the problems in his region which need study and that such study be continued until, (1) reasons for extreme variations have been determined, (2) fairly definite conclusions have been reached, and (3), a reasonably uniform method of procedure can be recommended.

3. That specific problems be assigned to different members of the research committee who will select members of a sub-committee to conduct necessary referee tests from which conclusions may be drawn and recommendations made as to desirable changes in methods of procedure.

4. That a limited number of general referee samples be submitted for study to those laboratories which have the time and interest to participate.

5. That the results of all cooperative research or referee tests be published as deemed advisable with due credit to each cooperating laboratory or individual concerned.

6. That increased attention be given to cooperative tests, (1) with commercial analysts, and (2), between individual laboratories.

7. That our efforts to understand the problems of the seed trade and cooperate fully with their association be continued.

8. That our association seek to eliminate as rapidly as possible causes for just complaint from seedsmen by, (1) determining the various causes for lack of uniform results, and (2), devising ways and means of conducting more uniform tests.

9. That the research committee undertake as a long time project, either by compilation of available data or by actual investigation, a study of the following problems:

a. Optimum conditions for the maximum germination of each species or kind of seed.

b. Effect of such factors as light, temperature, substrata, moisture, oxygen supply, pathogenic organisms, and seed disinfectants, both individually and collectively, on the germination of types of seeds.

c. Factors responsible for abnormal seedlings, together with descriptions and illustrations of abnormal seedlings among types of crop plants.

d. Agricultural value of hard seeds.

ACKNOWLEDGMENT

Without the encouragement and support of the President of our Association, official and commercial analysts, the regional chairmen, and many members of the seed trade, the work of this committee would have been less extensive and less valuable, if not impossible.—R. H. PORTER, *Chairman.*

REPORT ON THE HANDBOOK

E. BROWN

For the Research Committee

Your sub-committee on Handbook distributed in September, 1936, a mimeographed annotated table of contents of the proposed handbook.

Two of the analysts who are preparing chapters on special subjects have not been able to finish them up to the present time.

It is believed that after the revised Rules for Seed Testing have been acted upon, your next year's committee on the handbook will be better able to proceed with its preparation.

REPORT OF THE SUB-COMMITTEE ON REVISION OF THE RULES

At the last meeting your committee submitted a proposed revision of the "Rules for Seed Testing" with an explanation of the reasons for the arrangement, the material included, and the material left out.

A number of analysts have been kind enough to send in criticisms and suggestions for changes. These suggestions have been gratefully received and carefully considered.

There are presented at this time several changes and additions in the hopes of clarifying the presentation, but without changing the general plan of the original revision.

The sections dealing with the purity separation and varietal determination have been largely rewritten. In order to make clear what is to be separated and reported and to avoid past confusion between purity percentage and varietal purity, the term "pure seed" has not been used. These suggestions are not intended to change in any way the procedure in making a purity analysis, but it is hoped they will clear up any possible misunder-

standing of the results of the analysis. A form of report is presented, which it is believed will help to explain the intent of this portion of the rules.

There has been inserted under definitions of weed seed and of inert matter a provision that "undeveloped and badly injured weed seeds (including noxious weed seeds), which on visual examination are clearly incapable of growth" are to be considered inert matter and not weed seed.

It has not been found possible to follow all the suggestions that have been made and yet maintain a unity of presentation of the material. It may seem to many of you that various questions should have been treated more fully but, as stated last year, it is felt that these rules and recommendations should be a general guide, brief enough for ready reference, and that more extended treatment might better be reserved for the handbook. Numerous editorial changes have been made that do not change the meaning of the Rules.—E. H. TOOLE, *Chairman*, M. T. MUNN, W. H. WRIGHT.

Suggested Form of Report to Conform to Proposed Revision of Rules

Test Number	Sender's Mark	Name Under Which Submitted
0000	X Y Z	White sweetclover Atlas sorgo

Result of Analysis

Kind of seed (Name)	(Per cent)	Other crop seed (Per cent)	Weed seed (Per cent)	Inert matter (Per cent)
Sweet clover	95.0	2.2	2.2	0.6
Sorghum	98.0	0.0	2.0	0.0

Identification and Varietal Determination.

2% mottled seed present, indicating slight admixture of yellow sweetclover.
Sample is not Atlas sorgo—appears to be mainly Hegari, or
No attempt has been made to check the variety.

Weed seeds present			Other crop seeds present		
Kind	Number in ____grams examined	Per cent by weight	kind	Number in ____grams examined	Per cent by weight
A	5	——	X	1	——
B	25	2.0	Y	30	2.4
C	1	——			

Noxious Weed Seeds—rate of occurrence based on examination of 49 grams (entire sample).

Name	No. per pound	Name	No. per pound
Dodder.....	20		
Canada thistle.....	100		

or

Sample not examined for noxious weed seed content.

RULES AND RECOMMENDATIONS FOR TESTING SEEDS
ASSOCIATION OF OFFICIAL SEED ANALYSTS OF NORTH AMERICA

Adopted August 27, 1937.

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GENERAL INTRODUCTION

Seed testing has been developed to aid agriculture in avoiding some of the hazards of crop production by furnishing all possible information about seeds that are to be used for planting purposes. This information may be desired for labeling or other seed control purposes, for the seed producer or seed trade in connection with seed processing or merchandising, or as a guide to the person who will plant the seed, but, in all these cases, the ultimate purpose of making the test is to determine the value of the seed for planting. Many different types of information may be desired under different circumstances, for the planting value of seeds is influenced by many qualities.

There has been developed, especially in connection with the enforcement of labeling laws, a standard analysis, furnishing information as to the composition of the sample of seed and the ability of the seed to produce plants. However, other types of information may be desired in many cases.

It is desirable to have definitions and fundamental procedures agreed upon, but arbitrarily stated methods and detailed procedures will not lead to dependable results without a thorough knowledge of the principles involved. The rules and suggestions presented here should be followed as closely as is practicable.

Certain processes and definitions that form the basis of the standard analysis are presented as definite "Rules for Seed Testing" in Part I.

Part II, Recommendations for Testing Seeds, presents a general discussion of the principles involved in the various tests and suggestions as to procedure that are based on the past experience of seed analysts.

PART I

RULES FOR SEED TESTING

A. STANDARD ANALYSIS

The standard analysis for law enforcement, labeling and general information as to seed quality should determine for the sample analyzed (1) the purity composition; (2) an identification to determine the kind of seed and, if possible from appearance, the varietal composition; (3) the rate of occurrence of noxious weed seeds per unit weight, and (4) the percentage germination of the kind of seed under consideration.

1. THE PURITY ANALYSIS

The purity analysis is a separation of the material into the four components: kind of seed under consideration, other crop seed, weed seed, and inert matter, and a determination of the percentage by weight of each component.

a. *Obtaining the working sample.*—The working sample on which the actual analysis is made should be taken from the submitted sample in such a manner that it will accurately represent the submitted sample.

b. *Weight of working sample.*—For the detailed purity analysis, the working sample should be approximately of the weight given for the different groups of seeds. For any kind of seed not listed, use a weight that will give approximately 3,000 seeds.

(1) One gram: *Agrostis* spp.; *Poa* spp.; Rhodes grass; Bermuda grass.
(2) Two grams: Timothy; orchard grass; fescues (excepting meadow); alsike and white clover; carrot; Reed canary grass; Dallis grass.
(3) Five grams: Rye grasses (Lolium); meadow fescue; foxtail millet; alfalfa; red clover; sweet clovers; Lespedezas.
(4) Ten grams: Smooth brome; crimson clover; *Brassica* spp.; flax; *Agropyron* spp.
(5) Twenty-five grams: Proso millet; Sudan grass.
(6) Fifty grams: Sorghums; buckwheat; beet.
(7) One hundred grams: Vetches; cereals; sunflower.
(8) Five hundred grams: Corn; beans; peas; cowpeas; soybeans.

c. *Definitions.*

(1) Kind of seed under consideration. This should include all seeds of the kind under consideration whether shriveled, cracked, or otherwise injured: *Provided,* (a) That in case of broken seeds, any piece larger than one-half should be included, while pieces that are one-half or less should be considered inert matter; and (b) that seeds of legumes and crucifers with the seed coats removed, should be considered inert matter.

(2) Other crop seed. Seeds of plants locally grown as crops, other than the kind under consideration, should be considered other crop seeds unless designated as weed seeds.

(3) Weed seed. Seeds of plants recognized by laws or official regulations or by general usage as weeds should be considered weed seeds: *Provided,* That undeveloped and badly injured weed seeds (including noxious weed seeds) which, upon visual examination, are clearly incapable of growth should be considered inert matter and not weed seed. When a weed seed

is present that is exceedingly small (e.g. *Juncus tenuis*) and would not add appreciably to the percentage of weed seed, it need not be separated out with the weed seeds, but may be included with the inert matter. However, the presence of the weed seed should be recorded and reported.

(4) Inert matter. Broken seeds when one-half or less, seeds of legumes or crucifers with the seed coats removed, undeveloped and badly injured weed seeds which, upon visual examination, are clearly incapable of growth, dirt, stones, chaff, fungus bodies (such as ergot and other sclerotia and smut balls) and any other matter not seeds should be considered inert matter: *Provided,* (a) That in the case of grasses, empty glumes should be considered inert matter and only glumes containing caryopses (grains) considered pure seed; (b) that attached sterile glumes of grasses should be considered inert matter and should be separated from the fertile glumes, but with some grasses (e.g., Rhodes grass), where the separation of the sterile glumes would involve an excessive amount of work, this procedure may be omitted, but the report should indicate such variation from the usual procedure; and (c) that the presence of fungus bodies, when present, should be recorded and reported.

d. *Separation.* The working sample should be weighed and then separated into four parts: (1) Kind of seed under consideration; (2) other crop seed; (3) weed seed; (4) inert matter.

These four component parts should each be weighed in grams to the third decimal place, and the percentage by weight of each part (based on the sum of the weights of the component parts and not on the original weight) should be determined and recorded. In the case of other crop seed and weed seed, the seeds of each species should be separated where possible and the number or weight of each kind recorded.

The separation of the seed of the kind under consideration must be on such a basis that the separation can be made definitely by seed characters, and is non-varietal. The designation of the seed which is separated as the kind under consideration should be clearly stated on the records and the report. Information as to varietal composition should be a separate determination (See Identification and varietal determination).

When the sample contains two or more very similar seeds where the separation in the entire working sample would be difficult, it is permissible to separate and weigh the similar seeds as a group. From this mixture, at least 400 seeds are to be counted indiscriminately and the separation made on this small portion. The proportion of each kind is then determined by count or weight and from this the percentage in the entire sample is calculated.

e. *Duplicate analysis.* When a purity analysis indicates a value that is on the border line of a law violation or label statement, one or more additional analyses should be made and the average of all analyses used.

2. IDENTIFICATION AND VARIETAL DETERMINATION

The separation representing the kind of seed under consideration should be examined to determine if it conforms to the name under which it was submitted, or for further information as to varietal composition. If such identification is not possible from seed characters or is not attempted, such fact should be recorded and clearly reported. In many cases, varietal determination is pos-

sible only from seedlings or mature plants. If a growing test for this purpose is planned, this fact should be reported.

3. Noxious Weed Seeds

The determination of the number of seeds of individual noxious weeds present per unit weight should be made on at least the following minimum quantities for the various classes of seeds listed above under weight of working sample: (1) 25 grams; (2) 50 grams; (3) 50 grams; (4) 50 grams; (5) 150 grams; (6) 300 grams; (7) 500 grams.

Where the noxious weed seeds are present in small numbers, a larger quantity must be examined for reasonable accuracy of statement of rate of occurrence. See Part II for further discussion.

4. Germination Tests

a. *Purpose and method of germination.*—The object of a germination test is to determine the ability of the seed to produce normal seedlings capable of continued development in the soil under favorable conditions. Germination tests are to be carried out by such methods as will furnish suitable conditions for each particular kind of seed. The general principles and recommendations in Part II are to be followed as far as practicable.

b. *Source of seeds for germination.*—Seeds for germination are to be taken from the separation of the kind considered and should be counted without discrimination as to size or appearance.

c. *Number of seeds for germination.*—At least 400 seeds from a sample should be tested for germination. In order to have a check on the germination conditions, these seeds should be used in separate tests of 100 seeds or less each.

d. *Retests.*—When there is excessive variation among the separate tests, or other indication that the result obtained may not represent the value of the sample, retests should be made. A difference, among four separate hundreds tested, of 10 per cent when the average is 80 per cent or above, and of 15 per cent when the average is below 80 per cent, may be looked upon as an indication of excessive variation.

e. *Definition of germination.*—Since we wish to obtain as a result of the germination test the percentage of seeds capable of developing into useful plants, a seed will be considered to have germinated when it has developed into a normal seedling which might be expected to continue its development in soil under favorable conditions.

The final basis for judging normal seedlings is an intimate first hand knowledge of the behavior of various types of seedlings under favorable conditions in the soil.

Seeds which remain hard at the end of the test because they have not absorbed water, due to an impermeable seed coat, are to be counted and reported as "hard seed".

B. Evaluation and Reports

1. Tolerance

Owing to the natural variaton between samples from the same bulk, various analyses of the same lot of seed will fluctuate around the true value

for the entire bulk. When comparing the results of two or more analyses, a certain amount of variation is to be expected.

The limit of variation reasonably to be expected between an analysis or test based on the quantities specified in the rules and the given value is recognized as a "tolerance". When a result exceeds this "tolerance" it may be desirable to secure more information by further testing.

The tolerance formula is to be applied to the given analysis or test.

a. *Purity tolerance.*—For each determination the sample shall be considered as made up of two parts: (1) The component being considered, and (2) the balance of the sample. The tolerance in per cent allowed for each component shall be two-tenths of 1 per cent (0.2 per cent) plus 20 per cent of the lesser of the two parts.

b. *Noxious weed seed tolerance.*—A concise statement of tolerance for noxious weed seeds is not feasible. A discussion of the variability to be expected will be found in Part II.

c. *Germination tolerance.*—The following tolerances should be recognized between a given germination and the result of the germination test:

Given germination (per cent)	Tolerance (per cent)
96 or over	5
90 or over but less than 96	6
80 or over but less than 90	7
70 or over but less than 80	8
60 or over but less than 70	9
Less than 60	10

2. Hard Seeds

In reporting the germination of seeds, a portion of which remain hard at the end of the test, the actual percentage of germination should be reported and also the percentage of seeds remaining hard.

3. Reports

All reports should show the date of receipt of the sample, the serial test number, the name of the seed under which the sample was submitted, the sender's identification mark, and such other information as may be necessary.

The report of the analysis should state the designation of the kind of seed separated as the kind under consideration, together with its percentage by weight; a statement of identification or varietal determination, if such has been made, or if not made, a statement to this effect; the percentage by weight of the remaining components of the separation; a statement of the rate of occurrence of noxious weed seeds, if such a determination has been made, and if not made, a statement to this effect; and the percentage of germination of the kind of seed under consideration. If a standard analysis has not been made, or if additional information has been obtained, such information regarding the sample as has been determined should be presented in such a way as to be clearly understood.

PART II—Recommendations for Testing Seeds

A. Introduction

These recommendations attempt to summarize and make useful the accumulated experience of the seed analysts of North America. Although

it must be recognized that each sample to be studied presents its own problems and that conditions in different laboratories vary, these outlines of fundamental principles and suggestions from past experience should aid in obtaining a helpful knowledge of seed quality.

B. The Sample

Ordinarily it is not the duty nor opportunity of the analyst to take samples, but he should be prepared to suggest the best procedure. No matter how accurately an analysis is made it can show only the quality of the sample submitted, therefore every effort should be made to insure that the sample furnished shall represent the bulk of the seed in question.

1. Method of Taking the Sample

In order to secure a representative sample, equal portions should be taken from evenly distributed places throughout the lot of seed. Access should be had to all parts of the shipment. For the proper sampling of closed bags or large bulk shipments, it is necessary to use a sampler or trier. Various types of these have been developed.

a. The short thief, commonly used for sampling bags, removes seed only from the surface of the bag and should not be used unless the seed is known to be uniformly bulked.

b. A long thief, approximately 18 inches long, that will reach the center of the bag and with one entrance near the tip, is satisfactory if carefully used.

c. A long trier, or probe, approximately the length of the bag to be sampled, with numerous perforations that may be opened after insertion of the trier, has proven satisfactory but usually requires opening of the bag.

d. Grain samplers of the same type as (c) are suitable for large seeds and bulk shipments.

Closed bags should be sampled with a trier or bag sampler long enough to reach the center of the bag, or with a long trier or probe extending the full length of the bag.

In sampling open bags, it must be recognized that the sample may not represent the original shipment.

Bulk seeds in bins, cars, or other containers are to be sampled with a long trier or probe extended through the bulk in several places.

In sampling packet seeds, take entire packets.

2. Number of Bags to be Sampled

In lots of five bags or less, each bag should be sampled. In larger lots, sample every fifth bag, but never less than five bags. As the bag is sampled, the seed should be examined, and whenever there is evidence of lack of uniformity in a lot of seeds, each bag should be sampled separately.

The samples from each bag may be kept separate or they may be combined in composite samples as circumstances require.

3. Preparing the Sample to be Submitted for Analysis

The total quantity of seed drawn may be in excess of that required for such sample. It is very important that the seeds should be thoroughly mixed in taking the sample that is to be sent for analysis; if possible, a mechanical divider should be used to obtain the desired quantity.

Official samples should be sealed and all samples carefully and fully labeled.

4. SIZE OF SAMPLE

The following are minimum weights of samples to be submitted for an analysis:

a. Two ounces of grass seed not otherwise mentioned, white or alsike clover, or seeds not larger than these.
b. Five ounces of red or crimson clover, alfalfa, ryegrasses, bromegrasses, millet, flax, rape, or seeds of similar size.
c. One pound of cereal, vetches, or seeds of similar or larger size.

If the sample is to be examined for origin at least five times the quantities here specified should be submitted.

C. ANALYSIS OF THE SEED

The standard analysis should be the basis for seed labeling and for law enforcement and the analyst should follow the Rules of Part I closely in such work. However, the seed analyst may be called upon for information of other types and for other purposes where modification of the above methods would be better suited to give the most useful information. At certain times, the kinds and numbers of weed seeds present, determined on a large sample, may be more useful than the percentage of weed seed by weight determined on a smaller sample, or the origin of the seed may be the only information desired.

1. OBTAINING THE WORKING SAMPLE

Whenever the actual work is done on less than the entire sample received, great care should be used that the working sample is taken in such a way that it is representative of the larger sample.

The general principle should be observed of taking small representative portions from many parts of the sample, exercising care that difference in size, shape, or weight of the component material does not cause unequal distribution.

The material may be spread out in a thin uniform layer and small portions taken from evenly spaced places, or a uniform pile may be made and this split repeatedly until the desired quantity is obtained.

With free flowing seeds, some form of mechanical divider is desirable in order to remove the personal element from the process of splitting the sample repeatedly. The construction should be such as to divide a stream of seed into many small portions, evenly distributing all types of material and not allowing any of the material to catch in the divider.

The size of the sample desired will vary with the determination to be made. The sample for the standard purity analysis has been specified in Part I. Since the particles in a sample are of approximately the same size, and analysis is for the distribution of particles, the working sample for various types of seeds should contain approximately the same number of particles.

2. RELATIVE SIZE OF SEEDS

The size or weight of individual seeds in a sample may vary greatly, and also the average weight of seeds of a given kind will vary in different samples, depending on the season and region of production. In some crops the varietal difference will be large. However, it is useful to have a guide to the number of seeds to be expected in an average sample of the different crop seeds. In-

formation available has been summarized in Table 1. The numbers are based on tables given in the following publications:

Dorph-Petersen, K. 1922. Beretning Fra Statsfrokontrollen. Copenhagen. (Average for ten years' results).

Gross, E. 1897. Grundregeln des Futterbaues. 23 p. Leipzig.

Jenssen, C. 1879. Untersuchungen über den Kulturwerth der Handelssaaten unserer gewöhnlichsten Klee-und Grasarten. Landw. Jahrb. 8:136, 170–173.

Munn, M. T. 1924. Rules for Seed Testing. N. Y. State Agr. Exp. Sta. Circ. 73, 15 p.

Nobbe, F. 1876. Handbuch der Samenkunde. 631 p. illus. Berlin.

Stebler, F. C., and Volkart, A. 1913. Die besten Futterpflanzen. Ed. 4, v. 1, Berlin.

Various members of the Association have furnished data where no published information was available.

3. APPARATUS

A reading glass of 1½ magnification for separation of seeds.

A hand lens (magnification of 6x or 7x) with a large flat field is used for the separation and identification of seeds.

A binocular or dissecting microscope should be available for identification of some seeds.

A suitable mechanical divider helps to remove the personal element in obtaining the working sample.

An air blast or blower is an aid in the accurate separation of chaff and other light material.

Provision should be made for the examination of grasses by transmitted light as an aid in determining the presence or absence of a caryopsis.

4. STANDARD PURITY

This analysis is to determine the percentage by weight of (1) the seed under consideration; (2) other crop seed; (3) weed seed; and (4) inert matter.

The actual separation is carried out on a paper or glass in such a way that there will be no loss of the various components. Care should be used that the portions are not exposed to extreme conditions of humidity as loss or gain in moisture may cause an appreciable change in the proportion of the various components.

No accurate separation of seeds as to viability based on appearance is possible; therefore, all seeds of the kind under consideration should be separated and their viability determined by a germination test.

Because the standard purity must be a laboratory determination based on seed characters with the results expressed as a definite percentage by weight, the seed must be separated on a basis which permits a definite separation, and which is not varietal. Since the basis of separation may be broader than the name under which the sample was submitted, it is important to state definitely on the record and make clearly evident on the report the basis for such percentage separation. Information as to varietal composition but on a less definite quantitative basis may be possible, but should be a separate determination.

TABLE 1.—*Number of crop seeds per unit weight*

Kind of seed	Minimum weight for purity analyses (grams)	Approximate number of seeds per gram	Approximate number of seeds per ounce
Alfalfa	5	500	14,170
Barley	100	30	850
Beet	50	54	1,530
Bentgrass	1	18,000	510,300
Bluegrass, Canada	1	5,500	155,920
Bluegrass, Kentucky	1	4,800	136,000
Bluegrass, rough	1	5,600	158,760
Brome, smooth	10	300	8,500
Buckwheat	50	45	1,275
Carrot	2	900	25,510
Clover, alsike	2	1,500	42,520
Clover, crimson	10	330	9,350
Clover, red	5	600	17,010
Clover, white	2	1,500	42,520
Dogtail, crested	2	1,900	53,860
Fescues, fine-leaved	2	1,200	34,000
Fescue, hair	1	3,200	90,720
Fescue, meadow	5	500	14,170
Flax	10	300	8,500
Foxtail, meadow	2	1,200	34,000
Grass, Bermuda	1	3,940	111,700
Grass, orchard	2	1,150	32,600
Grass, reed canary	2	1,200	34,000
Grass, Sudan	25	120	3,400
Grass, velvet	2	2,500	70,870
Lespedeza, Chinese, hulled	5	820	23,250
Lespedeza, common, unhulled	5	750	21,260
Lespedeza, Korean, unhulled	5	525	14,880
Millet, foxtail	5	470	13,320
Millet, Proso	25	180	5,100
Oatgrass, tall	10	330	9,350
Oats	100	28	790
Rape, winter	10	230	6,520
Redtop	1	11,000	311,850
Rye	100	40	1,130
Ryegrass, Italian	5	500	14,170
Ryegrass, perennial	5	500	14,170
Ryegrass, short-seeded perennial	5	700	19,840
Sorghum, amber	50	55	1,560
Sorghum, kafir	50	50	1,420
Sweetclover	5	570	16,160
Timothy	2	2,500	70,870
Turnip	10	340	9,640
Vernalgrass, sweet	2	1,600	45,360
Vetch, common	100	19	538
Vetch, hairy	100	36	1,000
Wheat	100	25	708
Wheatgrass, crested	10	425	12,050
Wheatgrass, slender	10	340	9,640

In all determinations based on a sample there will be variation in the results of repeated tests. When it is desired to have more assurance of the accuracy of results, as when an analysis indicates a value on the borderline of a law violation, one or more additional analyses should be made and the average of all analyses used.

Mixtures of different kinds of seeds present special problems. When seeds of different sizes and shapes are mixed together, there is great difficulty in keeping the components equally distributed. This makes the securing of a representative sample very uncertain. These things should be considered before spending the necessarily great effort of making detailed analyses of such mixtures.

5. IDENTIFICATION AND VARIETAL DETERMINATION

Because exact percentage separation of the kind of seed under consideration is on a non-varietal basis, this separation should be examined for information as to varietal composition from appearance of the seed, although the determination may be less definite. If possible, the conformity of the seed to the name under which it was submitted should be determined. Lack of such conformity may be determined when positive identification of kind or variety is not possible. In some cases, as with yellow and white sweetclover, the two kinds cannot be completely and definitely separated from appearance of individual seeds on the basis of present knowledge, but the presence of admixture can be detected. Varietal identification from appearance of the seed may be possible in some cases and yet not attempted by the analyst. In any case, both the record and the report should clearly state whether identification was attempted, and if so, the degree of identification.

In many cases, varietal identification is possible from seedling characters or it may be desirable to grow plants to maturity for such identification.

6. NOXIOUS WEED SEED CONTENT

The content of seeds of noxious weeds is usually stated in numbers per unit weight. It is often important to determine the rate of occurrence with reasonable accuracy even if such rate of occurrence is low. The accuracy of such a determination depends on the number of individuals found rather than on the amount of sample examined. When small numbers of individual particles are concerned, as is usually the case in testing for noxious weed seeds, it is not possible to state definitely the amount of seed to be examined for a desirable accuracy of statement of the rate of occurrence. The variability to be expected for different rates of occurrence can be found in Pearson's* Tables of the Poisson distribution.

A rearrangement of material from Pearson's Table 52 is given as Table 2. This shows, for any given rate of occurrence, the maximum values that might be expected for a few selected degrees of certainty. The actual number found should be compared with the supposed rate of occurrence. This table should serve both as a guide to the amount that should be examined in any given case and also as a guide to the variation to be expected in repeated tests or to determine a tolerance suitable to a particular case.

Examples of use of Table 2. A lot of seed is labeled *10 dodder to the ounce.* An ounce is examined and 23 dodder seeds are found. Reference to the table shows that had there been dodder at the rate of 10 per ounce there would have been less than 1 chance in 1,000 of finding as many as 22. This would seem a satisfactory degree of certainty that dodder is present at a greater rate than indicated on the label and it would not seem necessary to examine more. Another lot of seed is labeled *160 dodder to the pound.* One ounce is

*Pearson, K. Tables for Statisticians and Biometricians. 1914.

examined and 17 are found. Reference to the table at a rate of 10 (160 per lb. = 10 per ounce) indicates that there is about one chance in 20 that as many as 17 would be found in an ounce if the rate actually were 160 per pound. This is a strong indication that the sample contains more dodder than the label states, but most analysts would desire more information before recommending prosecution. A second ounce is examined and 16 are found. The table indicates that if 20 were present there is only about one chance in 100 of finding as many as 33 (17 + 16). A third ounce shows 19. The table at a rate of 30 indicates a very remote chance of finding as many as 52 (17 + 16 + 19).

Had the second ounce shown 10, the table would indicate that the 27 found in 2 ounces might be expected about once in ten trials of two-ounce samples, even if the label were corrrect.

TABLE 2.—*Range of values to be expected for a few selected degrees of certainty for rates of occurrence from 1 to 30, adapted from Pearson's Table of Poisson Distribution*

Given or expected number	Numbers as large as those below are not to be expected more often than once in:			
	10	20	100	1000 trials
1	3	4	5	6
2	5	6	7	9
3	6	7	9	11
4	8	9	10	12
5	9	10	12	14
6	10	11	13	16
7	11	13	15	17
8	13	14	16	19
9	14	15	18	21
10	15	16	19	22
11	16	18	20	24
12	18	19	22	25
13	19	20	23	26
14	20	21	24	28
15	21	23	26	29
16	22	24	27	31
17	23	25	28	32
18	25	26	30	33
19	26	27	31	35
20	27	29	32	36
21	28	30	33	37
22	29	31	35	39
23	30	32	36	40
24	31	33	37	41
25	33	34	38	43
26	34	36	40	44
27	35	37	41	45
28	36	38	42	47
29	37	39	43	48
30	38	40	44	49

**Proc. Inter. Seed Testing Assn. 1937.

Further discussion of this problem and additional tables are presented in an article by Józef Przyborowski, "On undesirable errors due to insufficient size of seed clover samples tested for dodder."**

7. Special Methods

There may be many times when some other method than the standard purity analysis will give the desired information. The analyst should be ready to adopt methods best suited to the problem at hand. When special methods are used the report should clearly indicate this, so that the results will not be confused with results from a standard analysis. The following are suggestions of some useful special methods:

a. *Pure seed approximation.*—The pure seed of chaffy grasses or samples with much broken seed can be determined approximately without a determination of other components. This is useful for an expression of the live pure seed content of a sample.

b. *Number of weed seeds per unit weight.*—A determination of the number of weed seeds per ounce or other unit weight based on the examination of a comparatively large sample, may be desirable in place of or in addition to the standard separation.

c. *Examination.*—In some cases a simple examination or inspection of the sample will permit a statement of the relative proportions of various components or the presence or absence of adulterants. This is a useful method to furnish general information about mixtures and samples of uncleaned seed.

d. *Direct method.*—When only the plant producing power of chaffy or unclean samples is desired, the number of seedlings produced by a unit weight of the sample may be determined directly.

e. *Bushel weight and 1,000 kernel weight.*—These determinations are often desirable to give further information as to the seed quality.

8. Determination of Origin

The place of production of a sample of seed may often be determined from the incidental weed seeds or other materials that are characteristic of certain regions. The size of sample that must be examined will depend on the content of characteristic material. Usually, any conclusion about the origin of a particular lot of seed can be based only on the agreement of various indications obtained by the study of the incidental matter in a large sample. A list of the incidental seeds in alfalfa and red clover is given in the Proceedings of the International Seed Testing Association, Vol. 2, No. 6, pp. 1–22, 1928. Further information on seed origin is given by Gentner.[1]

D. Germination

Germination tests are made to determine what proportion of the seeds are capable of developing into normal useful plants. Many seeds require very definite conditions before they will start growth and these conditions may vary with the previous history of the seed. Also, certain seeds may start growth but may be so injured that continued development is impossible. Thus, the analyst is confronted with two problems in carrying out germination tests:

[1]Gentner, G. Die Herkunftsbestimmung der Kleesaaten. Proc. Inter. Seed Testing Assn., Vol. 9, pp. 1–81. 1937.

first, to induce growth in all seeds capable of growth, and second, to so interpret the test that the result will be of value to the ultimate user of the seed.

For purposes of seed testing, germination is defined as follows: A seed will be considered to have germinated when it has developed into a normal seedling which might be expected to continue its development in soil under favorable conditions.

1. Source and Number of Seeds

When a purity analysis has been made, the seeds for germination are to be taken from the separation of the kind under consideration, or from a separation made on the same basis as this separation. When only a germination test is made, the seeds of the kind under consideration are to be taken, but if the sample is appreciably impure, as cereals with many broken seeds, or in the case of chaffy grasses, it is desirable to make an approximate determination of the kind of seed under consideration and take for germination, seeds from this approximate separation. The approximate purity as well as germination should be reported. In all cases the seeds should be taken indiscriminately, without selection as to quality. When a sample has seeds of varying size or shape, great care is required that the seeds for germination are representative of the sample. Because the germination test is desired to show the proportion of seedlings to be obtained from the sample, all types of seeds should be included without reference to their apparent ability to grow.

It is usually considered that 400 seeds is the minimum to give reasonable accuracy in comparative tests, but cases may arise where sufficient accuracy for the purpose may be obtained with a smaller number.

2. Interpretation of Germination Tests

If our germination results are to be of value to agriculture, great care must be used in interpreting the results of the germination test. Since we wish to obtain as a result of the germination test the percentage of seeds capable of developing into normal seedlings, only such seeds should be counted as germinated which may be expected to continue their development in soil under favorable conditions.

Because artificial laboratory methods give abnormal conditions for development, the interpretation of such tests must rest ultimately on a first hand knowledge of the behavior of various types of seedlings in the soil under favorable conditions.

Injury to seeds during preparation for market often results in various types of broken seedlings. When any essential part of the seedling is thus destroyed, a useful plant is impossible. Improper conditions of storage or age of the seed may so weaken some part or parts of the seed that, although growth may start, continued development is impossible.

Seeds which remain hard at the end of the test because they have not absorbed water due to an impermeable seed coat are to be counted and reported as hard seed. Such seeds are usually, but not always, viable.

Swollen seeds that appear fresh should not be confused with hard seeds. Such swollen seeds may indicate weakened vitality, dormancy, or improper germination conditions. If more than 2 or 3% of fresh-appearing swollen seeds remain at the end of the usual duration of testing, the test should be prolonged or a retest made.

Disease, lack of vigor or other unusual conditions noted during the germination test should be recorded and reported if considered of importance.

3. Soil Tests

a. *Greenhouse soil tests.*—The testing of seeds in the greenhouse where they can be allowed to develop until established is necessary as a guide in the evaluation of seedlings. Also, in many doubtful cases and with many of the larger seeds, the greenhouse test is the best basis for judging the quality of a given sample. In many cases conditions are more favorable in the greenhouse than in the laboratory for normal seedling development.

A friable easily worked soil that does not bake or crust is essential. It has been found that covering the seeds with a layer of clean sand facilitates even distribution of water and prevents crusting of the surface. If the soil available contains "damping-off" organisms, the soil should be sterilized before use. The temperature range in the greenhouse should be such as is suitable for the germination of the kind of seed being tested. It is not necessary to have such close temperature control as with laboratory tests.

In most cases greenhouse testing is impractical during the hot summer months.

b. *Laboratory soil tests.*—As a partial guide in interpretation and as a basis for evaluation of some doubtful samples, it is desirable to make laboratory soil tests. Such tests are most useful for clovers that show broken seedlings and for some quick growing vegetable seeds. The high humidity of the germination chamber may cause difficulty in the interpretation of laboratory soil tests of lettuce, cabbage, and similar kinds of seeds. It is usually difficult to give sufficient space in the germinator for proper soil tests of beans and other large growing seedlings.

A standardized soil is not necessary, but suitable conditions of moisture and aeration should be provided for the germination of seeds. A soil should be selected that will supply sufficient water to the seeds without hindrance to aeration and that will not bake. A sandy loam or an equal mixture of good garden loam and sand (free from weed seeds) furnishes a suitable soil. Pure sand of proper size and texture has been used successfully to aid in the interpretation of certain types of samples.

Particular emphasis should be given to the proper degree of wetting of the soil. Water should be added to air-dry soil and thoroughly mixed with the soil. The proper moisture content of the soil can be tested best by picking up a handful and pressing it firmly by closing the hand. If the soil holds together in a ball when the hand is opened and yet crumbles easily when the ball is broken, the moisture content is suitable. After the soil has been properly wetted, it should be rubbed through a sieve and put in the containers for the seed test without packing. The seed should then be placed on the soil, evenly spaced and suitably covered with the same soil.

A suitable cardboard box or metal container should be used for the soil test. Paraffined light cardboard boxes, 4½ inches square and 1½ inches deep, have been found suitable. These can be used for 100 seeds of clover or seeds of similar size and 50 seeds of cereals.

If organisms causing "damping-off" are present in the soil used, they will develop very rapidly in the moist conditions of the germination chamber, making the test worthless. In such cases sterilization of the soil is necessary.

c. *Soil sterilization.*—Because of the prevalence of fungi causing "damping-off" in most cultivated soils, it is advisable to sterilize the soil before use, unless trial has shown this to be unnecessary.

Steam sterilization in an autoclave under pressure, or in a closed box, is a usual method. United States Department of Agriculture Farmers' Bulletin No. 1629 describes this method. Excessive heating of soil may develop toxic materials, especially in certain subsoils and soils with high content of organic matter. When the toxic property is developed from organic matter, airing the soil for about 24 hours before use, remedies the trouble. Electric soil sterilization is described in New York (Geneva) Experiment Station Bulletin No. 651 and in New York (Cornell) Experiment Station Bulletin 636. Some have successfully used home "pressure cookers", while others have used dry heat in a gas oven. The latter should be used only with soils with very little organic matter. Treating the soil with formaldehyde dust according to directions given with the product has been satisfactory.

4. LABORATORY GERMINATION

Although testing in soil, which is the natural medium for the germination of seeds, should be the guide in the interpretation of normal seedlings and the final basis for evaluation of questionable samples, the greater part of germination testing must be carried out in the laboratory with artificial media and controlled conditions. Kinds of seeds or individual samples that require special treatment or closely controlled conditions are tested satisfactorily only in the laboratory. It has been found necessary, in the laboratory, to provide fairly definite moisture, aeration, and temperature conditions for the different types of seeds.

a. *General information* (1) *Substrata.*—A substratum should be selected that will supply the needed moisture and yet allow sufficient aeration. Convenience and ease of counting should be considered. The following substrata are the most generally used:

Blotting paper.—Open and porous texture, free of ground wood or other fillers, free of chemicals injurious to germinating seeds, any coloring matter to be water insoluble, approximately neutral in reaction, weight 120 pounds to the ream. A grey or blue color is desirable for ease of counting of seedlings. When cut 6 x 9 inches and folded once they will fit economically on the trays in common use. These are used with the smaller seeds. Very fine seeds, those with a mucilaginous coat, or those that would not otherwise receive sufficient aeration, should be placed on top of the blotters; other kinds of seeds should be placed between the folds of the blotter.

Paper toweling.—An absorbent grade of approximately neutral reaction and free from injurious chemicals.

To be used for the larger seeds. These require more water and the less rigid material allows a greater area of contact with the seeds. Cotton flannel cloth may also be used with such seeds.

The seeds may be placed between folds of the paper, using the number of thicknesses that will supply sufficient moisture to the germinating seeds.

The *rolled test* uses paper toweling but the seeds are spaced farther apart and then the test rolled into a loose roll. It is of great advantage to lay the papers on a paraffin paper and roll together.

Soil.—A sterilized sandy loam, or in some cases a clean, sharp sand. Aside from its use in the interpretation of doubtful samples, soil may be

the most suitable substratum for some kinds of seeds in laboratory tests. Many samples that are difficult to germinate give better results in, or on the surface of soil. Seeds which are hastened in germination by the use of potassium nitrate solution will usually give equal results when tested on the surface of soil. For peas, beans, corn, sorghums, or similar seeds, it is often advantageous to use soil or sand. Moisture is supplied uniformly and the spread of molds is greatly lessened. The method of use is described under "laboratory soil tests".

(2) *Moisture and aeration.*—The substratum should be kept moist enough at all times to supply the needed moisture to the seeds, but should never be so wet that a film of water forms around the seeds. Excessive moisture may restrict the necessary aeration of the germinating seeds. Some kinds of seeds (e.g., spinach, pepper, and beet) are very sensitive to an excess of water, while others (e.g., timothy *Agrostis*, lettuce) require a liberal supply of moisture at all times. The exact supply of moisture required for each kind of seed will vary with the substratum and the humidity of the germination chamber.

(3) *Temperature.*—The provision of suitable temperature conditions is one of the most critical factors for satisfactory laboratory germination of many kinds of seeds. In some cases, the temperature requirements for germination can be provided without special equipment, but as a general rule laboratory germination requires artificial control of temperature. It is usually not necessary to have temperatures controlled closer than 1° to 2°C., but it is very important that the range suitable for a given kind of seed be provided. The temperature conditions that must be provided will depend upon the kinds of seeds to be tested, but for general seed germination work the following temperatures should be provided:

5° C. or 10° C., for prechilling. Necessary for many kinds of seeds when freshly harvested and for many tree and shrub seeds.

18°C. to 20°C. To be used for those seeds that are liable to be delayed in germination at temperatures above 20°C.

Daily alternation of temperatures.—The tests should be kept about 18 hours at the cooler temperature and about 6 hours at a warmer temperature. Many seeds germinate more readily with a sharp daily fluctuation of temperature. For others the alternation is a satisfactory method of obtaining a comparatively warm average temperature. In the use of alternating temperatures, the best effect is obtained by a sharp change of the temperature such as is secured when the tests are transferred between chambers maintained at all times at their respective temperatures.

20° C.–30°C. Alternation:—This is the most generally used alternation.

20° C.–35°C. Alternation:—The seeds of some warm climate crops require a temperature of 35°C. for a short period daily.

Still wider alternations have been recommended by some workers for various kinds of seeds.

(4) *Special treatments.*—In some cases special treatments may be of advantage to provide suitable conditions or to hasten the completion of germination.

Soaking.—In some cases soaking the seeds before they are tested is desirable, but care must be taken not to soak so long as to cause injury to germination or at a temperature above that to be used for germination.

Prechilling.—The test with the seeds on the moist substratum should be kept at 5°C. to 10°C. for varying periods before the usual test is started.

The special uses of this treatment will be discussed further under "special problems".

Predrying.—After-ripening of freshly harvested seeds is often markedly hastened by drying to the normal moisture content. A temperature not above 35°C. is desirable, and free circulation of air should be provided.

Light.—A number of kinds of seeds will germinate quicker and more completely if exposed to light during germination. The light exposure may be obtained by placing the tests in a window, by the use of artificial light, or by the aid of a daylight germinator, but in any case it is very important that the correct temperature and moisture conditions be maintained along with the light exposure. With some kinds of seeds (e.g., lettuce) a single brief exposure to light is sufficient, but with others (e.g., many of the grasses) a daily exposure of at least 4 hours is required. Some samples of a given kind of seed may require light while others do not. In general, freshly harvested seed is more likely to be benefited by light than older seed. There would seem to be a tendency for light to compensate for somewhat unfavorable temperatures.

Potassium nitrate.—It has been found that seeds benefited by light are also greatly hastened in germination if the substratum is moistened with a dilute solution of potassium nitrate. A potassium-nitrate solution made by dissolving 2 grams of the salt in 1 liter of water should be used for this purpose. Where fungi are present on the seeds, the nitrate solution may stimulate the fungus growth and result in injury to seedling roots. The use of soil as a substratum, will usually give results comparable to the use of a solution of potassium nitrate.

Where any special treatment is used to hasten germination, the treatment used should be mentioned in the report.

(5) *Apparatus. Germination chambers.*—The purpose of germination chambers is to maintain high humidity and to provide suitably controlled temperatures. "The essentials of a seed germination chamber" by W. L. Goss, Proceedings of the 18th annual meeting of the Association of Official Seed Analysts of North America, page 27, 1926, discusses the methods of providing the desired conditions. For seeds requiring light, a "daylight germinator" is desirable. The light of a north window is sufficient and reduces the difficulty of temperature control which occurs in direct sunlight.

Petri dishes.—Suitable moisture conditions for many seeds may be provided by Petri dishes. Absorbent paper toweling, filter paper, or other suitable substratum is placed in the bottom of the dish, throughly wet, and then drained of all excess moisture before the seeds are put in place. These dishes may be used to provide suitable moisture during light exposure, when a special chamber is not available. They also provide suitable conditions for the germination of some seeds, even when used in a germination chamber.

Vacuum counter.—Elimination of the personal element in selection of seeds for the germination test, as well as rapidity of work and even spacing of seeds on the substratum is secured by use of a vacuum seed counter. The construction of a suitable counter is described in United States Department of Agriculture Circular No. 53, 1928.

(6) *Placing the seeds.*—Care should be taken that the seeds are uniformly spaced on the substratum and that the seeds are given enough room to prevent contact during germination.

b. *Special problems.* (1) *Dormancy.*—The seeds of many fruits, and ornamentals, will germinate only after a prolonged treatment at a low temperature in a moist substratum. Soil, or peat moss and soil are usually the best substrata for such treatment. The test should be kept at 3°C.–5°C. for one to three months, keeping the substratum moist at all times. The completion of germination of seeds of many kinds of pine is hastened by such treatment.

(2) *Fresh seed.*—The seeds of many plants, when freshly harvested, especially if slightly immature when harvested, are in a condition of temporary dormancy and require different conditions for germination than the usual commercial sample. Usually a lower temperature is required than for older seed. Prechilling or keeping the test at a low temperature for a few days before starting the usual conditions is a satisfactory method for many seeds.

Keeping the sample where freely exposed to air at room temperature for from a few days to a month will often prepare it for normal germination.

Many kinds of seeds are benefited by light when freshly harvested, although light may not be necessary later.

Cereals.—The germination may be satisfactory at 15°C. or the test may be prechilled at 5°C. or 10°C. for 5–7 days before placing at 20°C. The exact time and temperature required will vary with season and sample.

Grasses.—Timothy, Kentucky bluegrass and ryegrass, as well as other grasses, may be greatly benefited by light for 1–3 months after harvest. Prechilling is favored by some as a treatment for fresh seed of grasses.

In the early part of the season, any unaccountably low germination should be suspected as due to fresh seed dormancy, and special methods should be used.

(3) *Poor quality seed.*—When a lot of seed, because of age or poor storage conditions, has begun to fall sharply in vitality or when a sample has been mechanically injured during harvesting or subsequent handling, special care is needed to determine the value of the seed. Such weakened seeds are more readily attacked by molds and the presence of these molds in the test may affect the development of seeds that are otherwise all right. A soil test in the greenhouse, or in some cases in the laboratory, will furnish the best conditions for the development of normal seedlings and will give the best evaluation of the sample.

(4) *Treated seed.*—Seeds which have been treated with certain fungicides for disease control may be so affected by the chemical that abnormal seedlings are produced in a towel or blotter test, whereas the same seed planted in the field or tested in soil would exhibit normal germination. Excessive treatment may cause abnormal germination not only in a towel or blotter test but also in the field or in soil tests. Seeds which show visible signs of treatment or exhibit symptoms of chemical injury in towels or blotters should be tested in soil in order to obtain a true indication of the normal germination.

(5) *Lettuce.*—The seeds of some samples of some varieties of lettuce will not grow without exposure of the moist seeds to light; they are also checked in germination by high temperatures. Such samples should be placed on a moist substratum and allowed to absorb water at temperatures from 10°C. to 20°C. for about two hours. The test should then be exposed to light for about one-half hour and then placed in the germinator. The same result may be obtained by testing in a daylight germinator kept at 20°C. or lower. Many lots of freshly harvested lettuce seed are benefited by prechilling.

(6) *Cotton.*—Cotton seed produced in parts of Texas and Oklahoma is often weakened in vigor without its viability being actually destroyed. Such seed will produce plants under favorable conditions, but will easily succumb under unfavorable conditions. When tested by the usual method the seeds often decay, although the seeds can be shown to have a high viability. When this condition is suspected, supplementary germination tests should be made by thoroughly pre-wetting the seed and blotting off the excess moisture before putting it to germinate. Shaking the seed in a closed container with a small amount of water, thoroughly wets the "fuzz" of the seed, facilitating rapid absorption of water. All excess water must be removed by blotting or poor germination will result. If the supplementary test is higher than the standard test, report both standard germination and live seed (as indicated by the result of the supplementary test).

(7) *Beet.*—It is recommended that the germination of beet be confined to the determination of the percentage of balls which sprout. Because of the varying sizes of beet balls in a sample, it is suggested that a mechanical divider be used in securing the balls for the germination test in order that the different sized balls will be represented proportionally in the test.

c. *Retests.*—Because of the variation of behavior of different samples, the analyst should continually watch for any indication that the result of the test may not represent the value of the sample, such as lack of complete germination, or the excessive development of fungi on account of the high humidity of the conditions of germination. Excessive variation among the separate tests may be due to variations in the material tested or to incomplete germination of one or more tests. When there is any indication that the results do not represent the value of the sample, retests should be made. All results should be averaged, except those that are considered inaccurate. A difference, among four separate hundreds tested, of 10% when the average is 80% or above, and of 15% when the average is below 80% may be looked upon as an indication of excessive variation.

d. *Duration of test.*—It is usually helpful to remove seedlings as they develop, in order to give the remaining seeds a better chance to germinate. Care should be used that seedlings are not counted and removed before they have had a chance to show whether they have the ability to develop into normal seedlings.

The length of time required for complete germination will vary with the previous history of the sample and the conditions of germination. The time required for completion of germination of the average sample is indicated in Table 3. If, however, germination does not seem to be completed in this time, additional time should be given. It is not safe to assume that swollen, undecayed seeds will produce normal seedlings. In many cases if these make any growth they may not continue development into normal plants.

When slow germination occurs and dormant or fresh seed is suspected, it is better to start a new test under conditions that are suitable for such seed rather than to continue the test under conditions that are unfavorable.

e. *Suggested methods for germination.*—The results of the experience of seed analysts and seed physiologists has been incorporated in Table 3 as definite suggestions for the laboratory germination of some of the more commonly tested seeds.

TABLE 3.—*Recommendations for laboratory germination*

Kind of seed	Sub-strata	Temper-ature °C.	First Count (days)	Dura-tion for aver-age sample (days)	Remarks
FIELD CROPS:					
Barley	T, S	20	3	6	Prechill fresh seed
Beans	R, S	20–30	5	8	Watch for "bald head" and other injuries
Beet	B	20–30	3	10	Soak in water for two hours before testing
Buckwheat	B, T	20–30	3	6	
Corn	R, S	20–30	4	6	
Cotton	T, S	20–30	4	7	Consult "Special Problems (6)"
Flax	TB	20–30	3	6	
Hemp	B	20–30	3	6	
Oats	T, S	20	4	7	Prechill fresh seed
Peas	R, S	20	5	8	
Rice	B, T	20–30	3	7	
Rye	T, S	20	3	6	
Sorghum, grain	B, S	20–30	3	6	
Sunflower	T	20–30	3	7	
Tobacco	TB	20–30	5	14	Light
Wheat	T, S	20	3	6	Prechill fresh seed
Wheat, durum	T, S	20	3	7	Dormancy frequent in fresh seed
FORAGE PLANTS:					
Grasses:					
Bentgrass	P	20–30	7	21	Light, Potassium nitrate
Bermuda grass	P	20–35	7	21	Light, Potassium nitrate
Bluegrass, Canada	P	20–30	7	28	Light, Potassium nitrate
Bluegrass, Kentucky	P	20–30	7	28	Light for fresh seed
Bluegrass, rough	P	20–30	7	21	
Brome, smooth	P, B, S	20–30	6	14	
Carpet grass	P	20–35	10	21	
Crested dogtail	P	20–30	10	21	Prechill fresh seed
Fescues, except meadow and hair	P	20–30	7	21	Prechill fresh seed
Fescue, hair	P	20–30	11	28	Potassium nitrate—prechill fresh seed
Fescue, meadow	P, B, S	20–30	5	14	
Meadow foxtail	B	20–30	6	14	
Millet	B	20–30	3	6	
Johnson grass	B, S	20–35	7	21	Often dormant and difficult to get complete germination
Oatgrass, tall	P, S	20–30	6	14	
Orchard grass	P, S	20–30	7	14	Germination often more rapid in soil
Redtop	TB	20–30	5	10	
Reed canary grass	P	20–30	5	14	Some samples benefited by light
Rescue grass	P, S	20–30	7	28	Light—low temperature for fresh seed
Rhodes grass	P	20–30	6	14	
Ryegrass	P, TB	20–30	5	14	Light and KNO_3 for Italian ryegrass when fresh
Sorghum, sweet	B, S	20–30	3	10	Fresh seed often slow
Sudan grass	B, S	20–30	3	10	

TABLE 3.—(*Continued*).

Kind of seed	Substrata	Temperature °C.	First Count (days)	Duration for average sample (days)	Remarks
FORAGE PLANTS:					
Sweet vernal grass	B	20–30	6	14	
Timothy	TB, P	20–30	5	8	Light for fresh seed
Velvet grass	B, P	20–30	6	14	
Wheatgrass, crested	B, P	20, 20–30	5	14	For fresh seed, prechill 6 days, then test at 20°C, or test at 15°
Wheatgrass, slender	B, P	20–30	5	14	Light
Legumes:					
Alfalfa	B, S	20	3	5	
Clover, alsike	B, S	20	3	6	
Clover, crimson	B, S	20	3	5	
Clover, red	B, S	20	3	5	
Clover, white	B, S	20	3	6	
Cowpeas	R, S	20–30	5	8	Watch for weevil injury to plumule
Lespedeza, Chinese	B	20–35	7	21	
Lespedeza, common	B	20–35	7	14	
Lespedeza, Korean	B	20–35	5	14	
Soybean	R, S	20–30	5	8	Watch for injured plumules
Sweetclover	B, S	20	3	6	Normal seedlings difficult to determine except in soil test
Vetch, common	T, S	20	3	10	
Vetch, hairy	T, S	20	4	14	
Other forage:					
Rape	B	20–30	3	5	
Turnip	B	20–30	3	5	
VEGETABLES:					
Asparagus	T	20–30	6	14	
Beans	R, S	20–30	5	8	Watch for "bald head" and other injuries
Beet	B	20–30	3	10	Soak 2 hours
Cabbage	B	20–30	4	10	
Carrot	B	20–30	6	14	
Cauliflower	B	20–30	4	10	
Celery	B	20–30	10	21	
Chicory	P, TS	20–30	5	14	Light, Potassium nitrate
Corn salad	B	20, 20–30	5	21	Possibly requires 15°C for fresh seed
Cucumber	T, S	20–30	3	6	Soil test often helpful
Dill	B	20–30	7	21	
Eggplant	B	20–30	7	14	Raise edge of blotters
Endive	P, TS	20–30	5	14	Light, Potassium nitrate
Kale	B	20–30	3	6	
Leek	B	20	5	14	
Lettuce	P	20	3	5	Light, consult "Special problems (5)"
Muskmelon	T, S	20–30	4	10	20–35°C. for fresh seed, soil test often helpful
Mustard	P	20–30	3	5	Light

TABLE 3.—(*Concluded*).

Kind of seed	Substrata	Temperature °C.	First Count (days)	Duration for average sample (days)	Remarks
VEGETABLES:					
Okra	R	20–30	4	14	
Onion	B	20	5	10	
Parsley	B	20–30	11	28	
Parsnip	B	20–30	6	21	
Peas	R, S	20	5	8	
Pepper	B	20–30	6	14	Raise edge of blotters
Pumpkin	T	20–30	4	7	
Radish	B	20	3	5	
Rutabaga	B	20–30	3	7	
Sage	B, S	20–30	5	14	
Salsify	T	20	5	10	Light or prechill for fresh seed
Savory	B	20–30	5	21	
Spinach	TB	10	5	14	Fresh seed and prickly-seeded varieties may require a longer time
Spinach, New Zealand	TS	20–30	5	28	Not too wet
Squash	T, S	20–30	4	7	Soil test often helpful
Sweet corn	R, S	20–30	3	7	
Tomato	B	20–30	5	14	
Turnip	B	20–30	3	5	
Watermelon	T, S	20–30	4	14	20–35°C. better for some samples, soil test often helpful
FLOWERS:					
Ageratum	TB	20–30	6	10	
Aster	B	20	5	12	
Alyssum	TB	20	5	10	
Balsam (Impatiens)	B	20	3	5	
California poppy	B	20	4	12	
Calendula	B	20	3	10	
Candytuft	TB	20	3	8	
Coreopsis	B	20	5	10	
Cosmos	B	20	3	10	
Hollyhock	B	20	5	16	
Larkspur	B	15	8	21	
Morning glory	B	20–30	5	14	
Mignonette	B	20	4	10	
Nasturtium	T, S	15	7	10	
Pansy	TB	20	6	12	
Petunia	TB	20–30	5	10	
Poppy	TB	15	5	10	
Portulaca	TB	20	3	8	
Salvia	B	20–30	5	14	
Snapdragon	TB	20	6	10	
Summer cypress (Kochia)	TB	20–30	3	6	
Sunflower	B	20–30	6	14	
Sweet pea	T	20	5	14	
Zinnia	B	20, 20–30	4	8	

Key for substrata

B = Between blotters
TB = Top of blotters
T = Paper toweling
R = Rolled test
S = Soil, or sand
TS = Top of soil
P = Petri dishes

Because seeds are living organisms and are continually changing, we may find samples which do not respond to the germination conditions specified. When these occasional, unusual samples occur, the experience and judgment of the analyst must be the guide to the method to be used, keeping in mind at all times that the purpose of making the germination test is to furnish information of value to the ultimate user of the seed.

E. Variety Determination from Seedling or Plant Growth

Information about variety is becoming more and more important. Because the determination of variety from appearance of the seed is not possible in many cases, the analyst should be equipped to determine variety by growing tests. In many cases it is possible for the analyst to determine variety from seedling characteristics, but in other cases it is necessary to grow plants to maturity in the field.

The fluorescence test is an aid in detecting impure strains or admixtures in perennial ryegrass, because of the fluorescence in ultra violet light of pure filter paper on which have grown seedlings of impure strains or of Italian ryegrass. Suitable conditions for examination of tests may be obtained by enclosing a bright electric light in a light proof box provided with an opening which is covered with a glass filter which permits only ultra violet light to pass (Corning red ultra No. 584 is suitable). Outside light may be excluded by working in a darkened room or by placing a black cloth over the box and observer.

F. Determination of Moisture Content

When it is desirable or necessary to make a moisture determination of the sample, this may be done by some one of the standard methods such as the drying method, the Brown-Duvel method, and the more recently developed electrical methods. In the case of the latter two methods, the instructions which accompany the apparatus should be followed closely.

The standard drying method consists of the taking of duplicate samples from the well mixed larger commercial sample. For small seeds 10 grams are used, for larger seeds 20 grams. If it is desired to hasten the drying process and approach an absolute drying, it is best to coarsely grind or crush larger seeds and take two exact weight samples from the well mixed, ground sample thus prepared. Place the samples in an oven and heat for at least 5 hours at 103° C after which they are removed and after cooling sufficiently are reweighed, before any reabsorption of moisture takes place. If the two determinations agree within 0.5 % of moisture then the average expressed to one decimal place is to be used as the moisture content.

All moisture content determinations are to be made only upon samples which are received in air-tight containers which prevent loss of moisture after sampling; otherwise the results would be valueless.

G. Determination of Seed-Borne Disease Organisms

Since seed stocks are known to be very frequent carriers of the causal organisms of important plant diseases, it is necessary that the analyst be prepared and the laboratory equipped to detect and to report the presence of those which can be determined with more or less certainty. The value of any seed stock is depreciated by associated fungi either of a parasitic or of a saprophytic nature. The opportunity for detection of these microflora best presents itself in the seed laboratory since the seeds may be examined either in the dry or in the germinating condition. These findings can be

given as additional information and frequently some recommendations may be made as to whether or not the seed stock is safe for cultural purposes or can be made so by proper seed treatment or whether it should be diverted to other uses.

It is generally accepted that there are three classes of seed-borne plant diseases, namely, (a) those which are carried externally adhering to the seed coats, (b) those carried internally within the seed tissue, and (c) those such as sclerotia, smut balls, etc., which are carried along mechanically with the seed stock and which may be reported quantitatively. There are fungi which are regarded as active parasites and often found on fresh strong seed. Usually, in such cases the infection is definite or clear-cut and the signs of the disease may be confined to individual seeds. On the other hand, there are other fungi, such as *Penicillium,* which are regarded as age or storage fungi, thus indicating or associated with weakened vitality. When a test under adequate control in other respects becomes quickly overgrown with fungi, or softened with bacterial decay, or both, that fact should be recognized and such statements as seem warranted should be made of such conditions.

A report concerning the findings as to seed-borne disease organisms, whether negative or positive, should state the method or other special technique employed in making the determination.

The following are some of the important plant diseases whose causal organisms may be recognized on the seed or seedling and the presence of which should be recorded and reported:

Anthracnose of beans, *Colletotrichum lindemuthianum*
Ergots of grasses, *Claviceps* spp.
Fusarium diseases of barley, peas, rye, wheat, *Fusarium* spp.
Late blight of celery, *Septoria apii*
Root-rot of barley and other cereals, *Helminthosporium* spp.
Root-rot and leaf spot of peas, *Ascochyta* spp.
Seedling blights and ear rots of corn, *Basisporium gallarum, Diplodia zeae, Fusarium* spp., *Gibberella saubinetii*
Seedling rots of corn, *Rhizopus nigricans, Penicillium* spp.
Smuts of cereals, *Ustilago* spp., *Urocysatis* spp., *Tilletia* spp., *Sphacelotheca* spp.
Tomato blight and rot, *Macrosporium* spp., *Phoma destructiva*

REPORT OF THE PUBLIC SERVICE COMMITTEE

The work of this committee during the past year has had to do with the following projects:

1. Publication in the trade journals of articles contributed by seed laboratories.
2. Publicity concerning the use of good seed.
3. Further consideration of recommendations made by W. L. Goss in Presidential Address in 1935.

PUBLICATION OF ARTICLES IN TRADE JOURNALS

The need of publicizing the work of our Association has been emphasized on several occasions. This emphasis has come from both within and without our ranks. In the report of the Executive Committee at our last annual meeting,

this matter was favorably considered and at the 26th Annual Meeting in 1933, Mr. Oswald, Editor of the *Seed World*, who is a past-president of our Association, stressed the desirability of publishing timely articles on seed testing in the trade papers.

Following a suggestion by former President Whitcomb and a request by President Elliott, the Public Service Committee solicited the laboratories for short articles of from 700 to 1,000 words for publication in the various trade journals.

Assurance from the editors of *The Seed Trade News* and *The Seed World* that articles which met with the policies of their respective papers, would be published from time to time, was first obtained. Following this, each member laboratory of the Association was solicited for suitable material. This solicitation was done by the members of the committee by regions.

As the result of this solicitation, six articles for publication were received. Three of these were published, while the other three were not considered as being timely or did not comply with the policies of the publishers, and are being held for further consideration. The references for the papers which were published are as follows:

1. Hay, W. D. Canada thistle seed production and its occurrence in Montana Seeds. *Seed World 41*, 7:6–7. 1937.
2. Stone, A. L. Good seed is first step in a good garden. *Seed Trade News 28*, 11:9. 1937.
3. Whitcomb, W. O. Tells seed value of light weight wheat. *Seed Trade News 28*, 7:9. 1937.

The lack of success of this venture appears to be due to two things. First, the members of our Association did not lend the support that it was anticipated that they would, and, as a result, but few papers from which to choose were received by the committee. Second, some of the material which was furnished was not suitable for publication in trade papers. This does not mean that the articles were not well written or did not deal with worthwhile subjects, but that they did not have the appeal and practical aspects which items in trade papers need. Both *The Seed World* and *The Seed Trade News* make a special appeal to people in business and aim to stimulate trade. To this end, the material which they publish must deal with the immediate needs of the readers and be of considerable commercial value.

Looking to the future and mindful of the best interests of our association, what course should the Public Service Committee follow in this matter? Shall we abandon the attempt to publicize our work in this way, or shall we urge our members to make an effort to write interesting and timely stories about their most interesting and worthwhile work and to set these up in such a way that the people in business will read them and become interested? The committee believes that we have not given this project a fair trial. Let us put more energy into it and see whether or not it is a good thing and worthy of support.

In looking over the titles of papers as listed on the program of this meeting, one is impressed with the variety of interesting things to be discussed; so many potentialities for timely and practical stories for the business man who is deprived of the privilege of attending a meeting of this kind. The International Seed Testing Congress, interstate labeling of seeds, requirements of state laws on hard seeds, experience with flower seed law, methods of analyzing bluegrass and orchard grass, seed-borne disease aspect

of seed testing,—these and many more have practical significance to the man in the seed business when properly presented.

Let us try this writing of stories for the trade papers another year, and, in so doing let us put more conscious effort into it. Everyone should contribute something. The committee will work them over and select out the ones best adapted for the various papers. Some may be best suited for publication in the *News Letter*.

PUBLICITY CONCERNING THE USE OF GOOD SEED

Cheap or "Bargain" Seed

A. L. Stone

In order to ascertain to what extent cheap seed was being sold in the various states and the efforts being made to discourage its purchase by farmers, a questionnaire was sent to the Agronomists and to the Secretaries of Crop Improvement Associations in these states.

Thirty-eight replies were received. Of these, 36 reported the sale of cheap seed in their states, and 2 reported none.

The seeds were brought into the states by trucks or through shipments by mail-order seed houses. Farmers were persuaded to buy them through advertisements in farm papers, seed catalogues, and by salesmen. By this is meant that during the depression, many more farmers have purchased this cheap seed than would have been the case in normal years.

Thirty-three states reported that efforts were being made to convince farmers that the purchase of this cheap seed was poor economy, while four reported nothing being done.

The methods used to educate the farmers were various. Twenty-four were using publicity in farm, daily, and local papers. Fourteen were holding meetings at which the results of using cheap seed were discussed. In eight states, county agricultural agents were active and extension workers were stressing the importance of good seed. Five states reported the use of the radio. Exhibits and demonstrations were used in five states.

Twenty-seven of these states reported distinct evidence that the campaign against cheap seed was effective and some reported excellent results. In seven states, only partial results were reported and in two states, no results were apparent.

Thirty-three states reported having seen fields on which it was very evident that cheap seed had been used. Two reported few such fields and three, none at all. The evidences as to the use of cheap seed were various. Twenty reported weed increase in the fields, and eight the presence of new weeds. Fourteen reported bad mixtures of crop seeds and 14, very thin crop stands. Four reported winter-killing through use of unadapted varieties and four reported complete loss of the crop.

The opinions as to the results of using this cheap seed were various. Twenty-one reported new weeds, 18 reported poor yields and 5 undesirable crop and weed competition with a consequent reduction in the crop.

Twenty-one reports stated that they would stress the educational program to stop the sale of cheap seeds and five stated they would be glad to do so if the facilities could be provided. Press notices, radio, exhibits, demonstrations, extension, and other meetings and personal correspondence were to be used in the campaign.

It is evident that much work still needs to be done to educate the farmers as to the false economy in the use of this cheap or bargain seed. Seed analysts should take an active part in this campaign. Farmers do not seem to realize that while they may save a dollar an acre on their seed, the result of its use may be the loss of 6 dollars an acre or more on the crop because of low germination, weed competition, and unadaptable seeds.

Every possible effort must be made through a constructive program to educate the farmers to the fact that the use of cheap seed is absolutely false economy.

RECOMMENDATIONS BY W. L. GOSS

After careful consideration of the recommendations made by Past-President Goss in 1935, the committee wishes to make the following recommendations:

1. That since recommendations Nos. 1, 2, and 5 have to do with procedure in testing, they be referred to the Rules Committee.
2. That recommendation No. 3 be tabled indefinitely as there have been some questions raised as to its practicability.—F. A. MCLAUGHLIN, *Chairman.*

REPORT OF QUALIFICATIONS COMMITTEE

This is a report of progress of the committee on qualifications. Our work has had to do with obtaining information on equipment now in use in the member laboratories and opinions of those in charge as to the necessary qualifications for people who are in charge of official seed testing laboratories and also for those who are employed as analysts. It has been the plan of the committee to study the equipment of the various laboratories in an attempt to find out if lack of standardization has anything to do with variation in results.

In June, a questionnaire was sent out and a generous response was received. When these replies have been studied, it is believed that much information of value will be obtained.

It is worthy of note at present that a recent visit of the chairman of the committee in England provided information to the effect that organizations over there, such as ours, have made available certain qualification requirements. These have been effectively used by civil service commissions and similar organizations which are responsible for making appointments. —W. H. WRIGHT, *Chairman.*

REPORT OF THE PUBLICATIONS COMMITTEE

The assembling of the material and the publication of the proceedings of the 23rd, 24th, 25th, and 26th annual meetings of this Association, together with the making of an index for all the proceedings, was the task which was assigned to this committee at the time of the annual meeting last year. These meetings were held at Cleveland, Ohio, 1930; Toronto, Canada, 1931; Fargo, North Dakota, 1932; and Chicago, Illinois, 1933.

This is a report of progress. Most of the material has been received by the committee from F. S. Holmes, who was Secretary during these years, and has been checked over and the number of pages computed. Some few of the committee reports and papers which were presented at the various

meetings were not with the material, as received, and letters were written to the authors of these asking for copies or notes which will enable the committee to make these proceedings as complete as possible. Special attention has been given to the registers of these meetings as it is recognized that an accurate record of the attendance is an important feature of every meeting. Copies of the registers were sent to each member laboratory of the association with the request that they be carefully checked and corrections made. The response to this request was prompt and did much to provide a complete register.

Special recognition is given to Mr. Holmes who preserved much of the material and has provided the committee with very complete minutes of each meeting. These minutes give in considerable detail the discussions which followed the presentation of the reports and papers and the record of actions which were taken.

After a careful consideration, it was decided not to abstract the papers and reports, but to publish them much as they were presented. Although the information given is not as valuable at this date as it was some 5 to 8 years ago when it was presented, it is a record of what the association members have done and should be preserved as such. The proceedings of the four years will be published in one volume. An estimate of the pages of typed material indicates that there will be approximately 300 pages or less of published material.

Competitive bids from two planograph companies and two printing companies indicate that a saving of about $400 can be made by having the material planographed rather than printed. Planographing 500 copies of the 300 page volume will approximate $720. As soon as the rest of the committee reports and papers have been received the material will be submitted to publishers.

The indexing of the proceedings up to and including the 22nd meeting has been completed. As soon as the proceedings are available up to date, this work will be completed. Both a subject and author index is being prepared. It is planned to have this index published under a separate cover. —W. O. WHITCOMB, *Chairman.*

REPORT OF THE EDITOR OF THE *NEWS LETTER*

During the past Association year we have had the pleasure of putting out nine issues of the *News Letter,* which I hope have met with your approval. There were certain circumstances which happened this year to have combined to facilitate the editing of the *News Letter.* In the first place I must acknowledge my great indebtedness to Messrs. Wright and Elliott, from whom I have received invaluable support; so much so, in fact, that we might be practically considered an Editorial Board rather than that one of us has been a single editor. Then, again, it happened that Mr. Elliott has been our president, which has meant that we have been able to get all the mimeographing and distributing done without cost to the Association. The only cost has been for the Association crest on the cover and cost of reproducing certain cuts in the Canadian issue, which has been taken up in the Treasurer's report.

Among these nine issues there were two which were more or less special numbers, the Christmas issue and the Canadian number. We hope the latter was not considered by some as too much of a good (?) thing!

We have attempted from time to time to relieve the tension of higher thinking by descent into the realms of frivolity, and, judging by the response to our nonsense, not without appeal to some of our members.

I should like to extend my sincere thanks to all those who contributed so ably and especially to those commercial analysts who contributed such interesting and pertinent matter to our pages.

We hope that all subscribers duly received their copies. Several subscriptions were sent in during the course of the year and these were added to the mailing-list, we hope, without fail. If we have missed anyone, our sincere apologies are herewith offered.

In conclusion may I say how much I appreciate having been given this opportunity of serving you.—C. W. LEGGATT, *Editor*.

CONTROLLING FLOWER SEED SALES

M. T. MUNN

Agricultural Experiment Station, Geneva, N. Y.

The analysis and testing of packets of flower seeds purchased under the New York flower seed law, which has been in force only a few months, shows a few very definite indications or trends. The results corroborate and substantiate the investigational work of previous years which lead to the enactment of the law. They show plainly the need of control measures to protect both the buyers of these seeds and also those dealers who are offering a very satisfactory and desirable line of flower seeds to the trade.

As regards viability of the various stocks, it must be stated that they varied from those which showed a very high and commercially satisfactory germination percentage down to those far too numerous packets which showed but few, if any, real viable seeds in the packet. Judging by their behavior in the germinators, it seems safe to conclude that much of this low germinating or unsatisfactory seed was simply old stock repacketed over and over again. Even though a statement of germinative ability is not required by the law, one seed house did label all of their flower seed packets with the correct percentage of germination, while another firm had their packets printed showing the word "germination" with a space provided for receiving the percentage figures. These new practices show certain trends of the trade.

The mechanical purity of some of the packets was far from satisfactory. They contained weed seeds, inert material, and seeds of other flower species quite unlike the commercial stocks on the market.

Field control plantings were not made as intended, owing to the lateness of the season and the condition of the fields at planting time. Enough evidence was gained, however, to show that there were some gross irregularities of varietal abuse. Control field work is a very essential part of any plan to properly regulate the sale of flower seeds.

There were many irregularities in nomenclature. In this connection the statute simply requires that the vendor state the *kind* and the *variety* of flower seed in the packet. Even under this very simple requirement there were quite a number of instances where the packeter or vendor did not give the required label information as is done by the leading seed houses. The

irregularities due to failure to give the correct kind of seed were confined to those cases where two very similar kinds were closely associated through general usage, as for instance, Morning Glory (*Ipomea*) and Moon Flower (*Calonyction*). The irregularities or failures in giving the correct variety name were far more frequent. In some cases the packeter gave simply the name of the *kind* of seed. Others followed the name or the kind of seed with terms such as "Mixed", "Mixed Colors", "Annual", "Biennial", "Mixed varieties", "Single", "Double", and "Single and Double" to designate the *variety* of the kind of seed in the packet. In some cases, it was impossible to determine by the variety names used, or the colors and character of the flowers illustrated on the packet, just what the vendor did mean as to variety name. From these very poorly and inadequately labeled packets, there were all gradations up to those which were very carefully illustrated and fully labeled, as for instance, "Aster, Double American Branching, Purple, Wilt Resistant Strain".

When some of these irregularities or varietal abuses as to nomenclature were discussed with the vendors, we were surprised to find that in some cases the packeter had left this important matter quite largely in the hands of the lithographer who printed and supplied the packets. Lithographers are not necessarily botanists or professional seedsmen, and may have no control over what is finally placed in the packet. This fact accounted for quite a number of the important irregularities or failures to name or describe the seed stocks correctly and adequately. Coupled with this situation, was the fact that a few packeters of flower seeds are not seedsmen at all and apparently have no working knowledge of the classification of the material with which they are working. In marked contrast to this, was the great bulk of flower seed packets from professional flower seedsmen or growers which were of exceedingly high class and quality in every way as far as all tests could reveal.

All in all, the facts showed that there is a great need for adequate and just flower seed control. A comparison of figures and performance showed that the same dealers who are placing low quality vegetable seeds in their packets also place the same low quality flower seeds in packets. The accepted and standardized trade practices and performance of the better flower seedsmen should be underwritten or supported by an equitable flower seed law to hold all of the trade to that point. What the real trade sets up as good practice, the law should fully support. The situation was well expressed by one professional seed grower who stated, "Under the present chaotic and competitive situation which exists in many places the seedsmen cannot use or exercise his responsibility." There are no flower seed control laws or regulations in many places. The seedsmen who are interested should get together and outline what they wish done to protect themselves from unfair competition and practices. The field is now open. Will they come forward with a workable plan or will they wait until some form of legislation, good or bad, is enacted?

NOTES ON A NEW SEED MIXER AND DIVIDER

A demonstration, in which some models of seed mixers and dividers were shown, was given by F. H. Hillman, formerly of the Division of Seed Investigations of the U. S. Department of Agriculture. These mixers were designed by Mr. Hillman for laboratory work and are especially adapted

to the sub-sampling of small grass seed. It is his thought that by using his improved mixer and divider, a somewhat smaller working sample can be used than when the original sample is not accurately divided.—Editorial Note.

APPLICATION OF THE CHI-SQUARE TEST TO PURITY ANALYSES OF BLUEGRASS SEED[1]

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In a previous paper,[2] reference was made to wide differences between the purity analyses of bluegrass seed reported by seed laboratories using subsamples from a given laboratory sample. Such differences frequently cause embarrassment and financial loss to the seed trade. Obviously, a study of natural variability in bluegrass samples using some uniform method of procedure should indicate to what extent the differences in purity analyses obtained in practice are due to variation and to what extent other factors are involved.

To investigate the variability in bluegrass seed lots, a number of samples were obtained from seed companies. These represented high, intermediate, and low purity, as well as different weights per bushel. Each sample was subdivided by the modified Boerner mixer until approximately 16 grams of each were obtained, from which 16 subsamples, each approximately one gram in weight, were further subdivided. From each set of 16 subsamples, four, five, or ten were selected at random for analysis.

All analyses were made in the same manner. Separation of crop seeds, weed seeds, stones, grit, and straw from the subsample was accomplished by hand with tweezers, but the separation of the empty from the fertile florets was accomplished almost entirely by means of a single unit constant speed motor and fan connected to a Holland Vertical Air Blast Separator. The detailed method of procedure was as follows:

1. A given subsample was weighed, placed in the base of the separator tube (2.8 cm. in diameter), blown with the dial set at 16, 17, and 18 for 2, 4, and 6 minutes respectively.

2. The portion of the subsample remaining in the base of the tube was considered as heavy, and all other material as light, after which both portions were weighed and the percentage of heavy calculated.

3. The heavy portion was placed on the purity board and all weed seeds and crop seeds, as well as stones, grit, stems, and other foreign matter removed, and placed in the inert or light portion. No bluegrass florets were removed.

4. The balance of the heavy portion was replaced in the blower and

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[1]Journal Paper No. J496 of the Iowa Agricultural Experiment Station, Ames, Iowa. Project No. 86. The writer is indebted to Dr. C. W. Leggatt for the suggestion that the air blast be applied gradually from low to the maximum, and also, to Prof. G. W. Snedecor for suggestions in applying the chi-square test to the bluegrass purities.

[2]Brown, E. O., and Porter, R. H. An improved method of testing seeds of Kentucky bluegrass (*Poa pratensis* L.). Proc. Assn. Off. Seed Analysts North America, *1935*: 44–49. 1935.

blown for five minutes with a dial opening of 17.5. Any florets blown over were examined with tweezers before being placed with the inert matter. In practice, seldom more than two dozen florets are removed by the second blowing except for samples with a low test weight per bushel.

5. The percentage of purity was then calculated on the basis of total final weight divided into the final weight of the heavy portion.

Following the purity determinations of all subsamples from a given sample, the chi-square and probability values were calculated for each set, using both percentage of heavy and percentage of pure as separate calculations. In using the chi-square test it was assumed that empty florets and other inert particles on the average were similar in size to fertile florets, hence each percentage was considered to represent the number of fertile florets that could be obtained from 100 particles. Since the mean weight of a sample was approximately one gram and pure bluegrass contains about 4,800 seeds per gram, the chi-square value first obtained by comparing the purity percentage was multiplied by 48, after which the probability was determined. The formula used for calculating chi-square (X^2) for bluegrass is as follows:

$$X^2 = \frac{sx^2 - \frac{(sx)^2}{n}}{pq} \times 100 \times 48$$

in which s = summation
x = a percentage value
p = mean of the percentages
q = 100 − p
n = number of sub-samples

The detailed results of the analyses, using two samples of seed each with 10 sub-samples, are shown in Tables 1 and 2, respectively. Examination of the data in the tables show that for samples No. 1 the probability was slightly below .05, whereas the probability for sample No. 3 was high. We may assume that one set of subsamples came from a homogeneous lot of seed and that the differences are due to natural variability of the sample. The value of .04 for sample No. 1 was so close to the arbitrary minimum of .05 that more tests should be made before assuming that the lot was not homogeneous.

Further evidence of the uniform performance and accuracy of the constant speed motor which indicates fairly constant air pressure is shown by the close agreement in germination of pure seed from two subsamples of the same lot and the number of sprouts obtained in the inert portion from any one subsample. For sample No. 3, germination in quadruplicate of pure seed from two separate subsamples was 74.0 and 73.8%, respectively. Number of sprouts obtained in the inert portion was four each for samples Nos. 1 and 3.

The complete data obtained from all seed lots included in the study are being published in a bulletin of the Iowa Agricultural Experiment Station, together with data on germination of bluegrass on different substrata. The data herein reported have been presented to indicate that the chi-square test for homogeneity is applicable to purity analyses with bluegrass when subsamples drawn from the same lot are analyzed by the modified method of procedure, using a constant speed motor and fan as herein described. For

bluegrass weighing approximately 10 pounds per bushel more or less, the final blowing of the heavy portion must be made at a dial opening of about 18.5 in place of 17.5 although blowing for a longer period than 10 minutes at 18 might remove all of the empty florets. This modification is based on a limited number of analyses with low purity lots, but since the bulk of the bluegrass seed which moves in commerce probably weighs 14 or more pounds per bushel it is believed that the method herein described is applicable in most cases and will result in greater uniformity if put into practice by all laboratories.

TABLE 1.—*Variation in bluegrass sub-samples as measured by a single unit constant speed motor and fan. Sample No. 1*

Sub-samples	Original weight	Weight heavy	Weight light	Total final weight	Heavy	Pure	Reduction from heavy
	Gms.	Gms.	Gms.	Gms.	%	%	%
a	1.093	.859	.234	1.093	78.59	73.00	5.59
b	1.090	.860	.229	1.089	78.97	72.51	6.46
c	1.111	.876	.233	1.109	78.99	73.17	5.82
d	1.115	.887	.227	1.114	79.62	73.31	6.31
e	1.090	.844	.246	1.090	77.43	71.01	6.42
f	1.092	.845	.247	1.092	77.38	71.11	6.27
g	1.088	.867	.221	1.088	79.69	73.21	6.48
h	1.102	.871	.231	1.102	79.04	73.12	5.82
i	1.079	.851	.228	1.079	78.87	72.94	5.93
j	1.069	.833	.236	1.069	77.92	71.57	6.35
Mean	1.092	——	——	1.093	78.70	72.50	6.20
χ^2	——	——	——	——	17.52	17.76	——
P	——	——	——	——	.04	.04	——
Differences between extremes	——	——	——	——	2.31	2.30	——

TABLE 2.—*Variation in bluegrass sub-samples as measured by a single unit constant speed motor and fan. Sample No. 3.*

Sub-samples	Original weight	Weight heavy	Weight light	Total final weight	Heavy	Pure	Reduction from heavy
	Gms.	Gms.	Gms.	Gms.	%	%	%
a	.999	.892	.108	1.000	89.20	88.06	1.14
b	1.045	.927	.119	1.046	88.62	87.63	.99
c	1.014	.906	.107	1.013	89.44	88.22	1.22
d	1.045	.927	.118	1.045	88.71	87.74	.97
e	1.006	.901	.105	1.006	89.56	88.66	.90
f	1.075	.967	.109	1.076	89.87	88.26	1.61
g	1.080	.972	.108	1.080	90.00	88.86	1.14
h	1.037	.926	.112	1.038	89.21	87.90	1.31
i	.951	.851	.100	.951	89.48	88.38	1.10
j	.977	.877	.099	.976	89.86	88.28	1.58
Mean	1.0229	.9146	.1085	1.0231	89.4	88.2	——
χ^2	——	——	——	——	10.74	6.96	——
P	——	——	——	——	.30	.65	——
Differences between extremes	——	——	——	——	1.38	1.23	——

A POSSIBLE MODIFICATION IN PURITY ANALYSES OF ORCHARD GRASS[1]

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Purity analysis of orchard grass has long presented a difficult problem to seed analysts. Wide differences in percentage of pure seed as determined by seed laboratories commonly occur.

The official laboratories of the United States and Canada have been following the "Rules for Seed Testing" as adopted by the Association of Official Seed Analysts of North America in 1926 (2).[2] These rules require that, for orchard grass, the sample be divided by a mechanical sampler until a working sample of approximately two grams is obtained. Weed seeds, crop seeds, and inert matter are separated from this sample. " . . . In the case of grasses, empty glumes should be considered inert matter . . . attached sterile glumes of grasses should be considered inert matter and should be separated from fertile glumes." The determination of sterile or fertile florets is made by pressing with forceps or fingernail, or by examination over diffused light. With this method it is left to the judgment of the analyst to determine whether the glumes are empty or contain a caryopsis. Distinguishing empty glumes from those which contain shriveled, immature, or soft caryopses is difficult for many analysts—a fact which probably accounts for some wide differences in purity analyses by different laboratories.

The time required to make a purity analysis of orchard grass by the official method varies from 1½ to 6 hours, depending upon the purity of the sample.

In 1921, Voigt (6) conducted a series of referee analyses including 22 European and American laboratories. Three samples of orchard grass were sent to each laboratory. The range of purity in all cases was greater than that allowed by the tolerance formula as given in the "Rules". The ranges were: Sample No. 1, 8%; Sample No. 2, 11.5%; and Sample No. 3, 59.9%. A series of referee orchard grass seed samples have been circulated by the A.O.S.A. of North America for purity analyses and germination tests. Thirty-seven of the official laboratories and 14 commercial laboratories participated in the first of the series in 1922 (1). The results of the purity analyses for the official laboratories, gave extremes of 26.00 and 87.7% pure seed, with a mean of 50.10%, and, for the commercial laboratories, the range was 40.56%. Another referee test conducted in 1925 (5) gave similar results, however, fewer laboratories took part and the range was smaller, being 6.05%, which was still beyond the tolerance range (2).

In the 1936–37 another referee series was circulated by the Research Committee of the A.O.S.A. and 14 official laboratories participated (3). The high and low purities differed by 16.3%. The probability that the range in results was due to sample variations is shown by the chi-square test to be

[1]Journal Paper No. J493 of the Iowa Agricultural Experiment Station, Ames, Iowa. Project 86.

[2]Numbers in parenthesis refer to Literature Cited.

much less than .01. From this it may be assumed that the variation was due largely to the interpretation of each analyst as to what was an empty floret.

The above data indicate that the application of the official mehod for purity determinations of orchard grass by individual analysts does not give uniform results.

In an effort to reduce the difficulties heretofore encountered, experiments similar to those of Brown and Porter (4) on *Poa pratensis* were conducted. To insure thorough mixing, the entire lot of seed was divided by the improved Boerner sampler, the subdivisions were combined, and the entire process was repeated three times. Four subsamples were selected for test by the official method. Each subsample was completely analyzed by the official method, the whole being checked over diffused light for empty florets. The sterile florets were removed from the multiple florets. Crop seeds, weed seeds, fertile florets, and inert matter were weighed and purity of the sample calculated. The data are given in Table 1, from which it may be noted that the results are uniform as indicated by the chi-square and probability values.

TABLE 1.—*Variations in replicate analyses of orchard grass by the official method of purity analysis*

Sub-samples	Original weight	Final weight	Time required[2]	Total inert material	Crop and weed seeds	Pure seed
	Gms.	Gms.	Min.	%	%	%
1	2.043	2.037	150	7.9	2.3	89.9
2	1.971	1.968	165	7.2	2.0	90.8
3	1.934	1.945	165	8.3	1.7	90.0
4	2.073	2.069	180	9.0	0.8	90.2
Total	——	——	665	32.3	6.9	360.8
Mean	——	——	165	8.1	1.7	90.2
X^2	——	——	——	——	—	1.5
P	——	——	——	——	—	.7

Five sub-samples of approximately two grams each were then selected for a test by a modified method. The weighed samples were placed in the medium sized tube of the Holland blower (3.8 cm. inside diameter). This blower tube was modified by inserting above the screen at its base a conical tube 4 cm. high and 3.7 and 2.7 cm. in diameter at the top and bottom, respectively. This modification was found necessary to eliminate eddy currents which prevented thorough blowing of the sample. To obtain uniform results it was found necessary to employ a constant-speed motor as part of the blower assembly. The samples were blown for 12 minutes with the vent opening at 21. With this equipment it has been possible to obtain uniform results of five sub-samples of the same lot as shown by the chi-square test for homogeneity. The data for the five sub-samples are given in Table 2. All blown inert material was checked over diffused light for the presence of fertile florets and 0 to 6 immature caryopses were found, but they were left in the inert portion which was placed in the germinator.

The heavy portion was separated into inert matter other than empty glumes, crop seeds, and weed seeds, multiple florets, and single florets. Each portion was weighed and the purity calculated, using an arbitrary figure of 20% of the multiple florets for the inert fraction, which was added to the

inert portion. This arbitrary constant had previously been determined by actual separation of multiple florets and was based on the mean of these determinations. The range in the percentage of pure seed for the five sub-samples was 0.88%. The probability of 0.80 is high, indicating homogeneity of the sample. However, the use of an arbitrary figure of 20% in determining the portion of multiple florets classed as inert, partially eliminated the consideration of natural variation in the multiple floret portion, hence the probability may be expected to be higher than is actually the case.

TABLE 2.—*Variations in replicate analyses of orchard grass by a modified method of purity analysis.*

Sub-sample	Original weight	Final weight	Time required[1]	Blown inert material	Multiple florets	Total inert material	Crop and weed seed	Pure seed
	Gms.	Gms.	Min.	%	%	%	%	%
1	2.160	2.145	42	3.3	25.3	9.5	1.2	89.4
2	2.226	2.201	37	3.4	24.9	9.5	1.8	88.8
3	2.137	2.179	37	2.9	24.4	9.1	1.7	89.2
4	1.973	1.962	42	3.1	27.0	9.4	2.0	88.6
5	2.013	2.015	37	3.0	27.9	9.4	2.1	88.5
Total	——	——	195	15.6	129.4	48.8	8.8	444.4
Mean	——	——	39	3.1	25.9	9.4	1.8	88.9
X^2	——	——	——	5.8	——	——	—	1.9
P	——	——	——	.2	——	——	—	.8

[1]Includes time of blowing.

The time required to make a purity test by the modified method is much less than that spent following the official method. For both high and low purity analyses, the time required ranged from 35 to 50 minutes, depending upon the crop seed, weed seed, and multiple florets present in the sample. This time included that taken for the blowing.

These results have been duplicated on several samples of both high and low purity. The complete data for these will be published subsequently.

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SOME COMPARATIVE STUDIES ON BLOWING METHODS OF *POA PRATENSIS*

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When the referee samples of *Poa pratensis* were submitted this year, the instructions regarding the blowing procedure for the samples were different from the method used in our laboratory for purity approximations. In our approximation, the sample is blown successively at increasing velocities until an examination of the blowings indicates that all light inert has been removed. Any pure seeds in the final blowing are removed. All foreign seed and inert, with the exception of attached glumes, are removed from the heavy seed. From this heavy seed, the approximate purity is obtained. It occurred to us that a comparison of the two methods might prove interesting. In the referee method,[1] the blower is calibrated by repeated trials to determine the velocity required to give the closest separation between heavy and light seed. This velocity is then used when making the actual test. The sample is blown at this velocity for ten minutes. There is no hand-picking of the light seed; the inert (except attached glumes) and foreign seeds are removed from the heavy portion. From this heavy seed, the purity percentage is calculated.

Since this laboratory does not use a specified period for blowing in making analyses of grasses, the question was raised as to the advantages and disadvantages of the two methods of blowing. A question was also raised as to the reason why a period of ten minutes was selected as the length of time to blow a sample. In view of this, it was decided to run tests in an effort to find out if ten minutes of blowing is preferable to a shorter period. To do this, the referee method was followed with the exception of the ten minute blowing time: this was varied from one- to ten-minute periods. A comparison of our own method, of the referee method, and of our modification of the referee method, was made in a series of tests on two separate bulks, the results of which are shown in Tables Nos. 1 to 6.

In the U. S. Department of Agriculture approximation method any deficiency in blowing is corrected by the removal of any pure seeds found in the last blowing or the removal of empty glumes from the pure seed, thereby removing any chance of mechanical error. In the referee method any pure seed that is blown into the lighter portion during the blowing period remains there because no hand-picking is used on the lighter portion. This gives a lower purity because it is not possible to separate all the light portion from the heavy portion by blowing alone. Even with very careful work, it is possible that the blower is not set at the identical velocity of blowing every time. It is also quite possible that heavy seed may be carried over by a group of light material when the blower is set at a definite point and the air turned on at this point instead of approaching it gradually

[1]As described in the referee sheet submitted 1936.

as is done by the U. S. Department of Agriculture method. This is shown in Table 2 and Table 6 in the wide variation of results by the referee method in a series of tests made on the same sample under identical conditions. These tables show that the use of several blowings of increasing strength, as in the U. S. Department of Agriculture approximation gives a closer separation of pure seed and much less variability than the single blowing at a definite setting used in the referee method. There is no way to correct this mechanical error by the referee method, but by the U. S. Department of Agriculture approximation any heavy seed blown over into the light portion would be removed and placed with the pure seed as shown in Table 3. The above remarks refer to the variations that occur with different tests on one sample. It has been our experience that it is not possible to calibrate a blower for all samples because samples taken from the same bulk vary and often need different velocities of blowings, and different bulks of varying weights per bushel need to be treated individually.

TABLE 1.—*Results obtained by the modified referee approximation compared with the U. S. Dept. Agriculture approximation and detailed purity. Tests made on separate working samples of Poa pratensis, No. 761275.*

Method	Working sample number	Length of blowing time	Purity	Germination from inert matter	
				Normal sprouts	Weak sprouts
		Min.	%	%	%
Modified referee approximation blown at 37 degrees...	1	1	70.73	29	20
	2[1]	2	77.08	—	—
	2[1]	2	76.98	—	—
	2[1]	2	74.10	12	29
	3	3	73.15	29	23
	4	4	71.68	9	13
	5	5	73.97	11	17
	6[1]	6	67.27	—	—
	6[1]	6	69.42	19	15
	7[1]	7	74.44	—	—
	7[1]	7	71.71	21	36
	8	8	72.98	3	9
	9[1]	9	67.86	—	—
	9[1]	9	69.43	17	21
	10	10	71.00	20	26
Average[2].....	—	—	72.12	17	21
Maximum.....	—	—	77.08	29	36
Minimum.....	—	—	67.27	3	9
U. S. Dept. Agr. approximation blown at 32, 34, 36, 37 degrees[4].....	11	5[3]	72.24	11	14
Detailed purity blown at 32, 34, 36, 37 degrees.....	12	5[3]	72.37	—	—

[1]These additional tests made under identical conditions indicate a variation in the working samples as well as a variation in tests of the same working sample.

[2]Average (total) time to complete the test, 26 minutes.

[3]Five minutes included the actual blowing time and the time required to empty and adjust the blower between each degree of blowing.

[4]Total time to complete the test, 33 minutes.

TABLE 2.—*Comparison of results of repeated tests on the same working sample (Poa pratensis sample No. 761275) by three methods.*

Percentage pure seed by[1]			
U. S. Dept. Agr. approximation	Referee approximation		
	10 Min. blowing	Varied blowing time	
%	%	%	Min.
70.62	64.30	67.70	1
70.43	66.57	66.99	2
70.90	66.96	64.31	3
70.08	65.80	64.99	4
70.78	65.10	64.60	5
70.55	62.82	65.96	6
70.89	65.89	64.31	7
70.12	66.35	65.44	8
70.25	64.46	64.76	9
70.35	65.55	64.30	10
Average 70.50	65.38	65.42	—
Average time 32 min.	25 min.	22 min.	—
Standard deviation .288	1.18	1.12	—

[1]In the number of times that this sample was weighed, the weight varied but there was not a consistent loss or gain; the weight fluctuated with the atmospheric conditions.

TABLE 3.—*Effect of hand-picking the blowings of the U. S. Dept. Agriculture approximation. Results of ten successive tests made on one working sample of Poa pratensis, No. 761275.*

Openings of blower	Heavy seed by blowing alone	Pure seed found in blowings	Total pure seed
	%	%	%
32, 34, 36, 37, 38	69.56	1.06	70.62
32, 34, 36, 38	68.39	2.04	70.43
32, 34, 36, 38	68.77	2.13	70.90
32, 34, 36, 38	67.96	2.12	70.08
32, 34, 36, 37, 38	69.03	1.75	70.78
32, 34, 36, 38	68.22	2.33	70.55
32, 34, 36, 37, 38	69.25	1.64	70.89
32, 34, 36, 38	68.77	1.35	70.12
32, 34, 36, 38	67.44	2.81	70.25
32, 34, 36, 38	67.93	2.42	70.35
Average	68.53	1.97	70.50
Standard deviation	.627	——	.288

TABLE 4.—*Comparison of the modified referee approximation with the U. S. Dept. Agriculture approximation. Tests made on one working sample of Poa pratensis, No. 761275.*

Method	Length of blowing time	Purity[1]
	Min.	%
Modified referee approximation, blown at 38 degrees[2]	1	75.31
	2	73.48
	3	74.54
	4	72.12
	5	71.83
	6	70.45
	7	72.30
	8	70.40
	9	70.69
	10	71.33
Average	—	72.25
Standard deviation	—	1.62
U. S. Dept. Agr. approximation blown at 32 34, 36, 37, 38 degrees[3]	5[4]	74.15
	5[4]	74.38
Average	—	74.27

[1]In the number of times that this sample was weighed, the weight varied but there was not a consistent loss or gain; the weight fluctuated with the atmospheric conditions.

[2]Average time to complete the test, 28 minutes.

[3]One test was made before and one after the tests by the referee approximation.

[4]Five minutes included the actual blowing time and the time required to empty and adjust the blower between each degree of blowing.

TABLE 5.—*Results obtained from the modified referee approximation compared with the U. S. Dept. Agriculture approximation and detailed purity. Tests made on separate working samples of Poa pratensis, No. 401508.*

Method	Working sample number	Length of blowing time	Purity	Germination from inert matter	
				Normal sprouts	Weak sprouts
		Min.	%	%	%
Modified referee approximation, blown at 36 degrees...	1	1	86.17	1	3
	2	2	89.10	0	0
	3	3	88.99	2	2
	4	4	87.85	2	0
	5	5	89.28	1	5
	6	6	87.82	1	8
	7	7	88.25	6	11
	8	8	87.40	2	10
	9	9	86.52	7	12
	10	10	88.32	10	23
Average[1]	—	—	87.97	3	7
Maximum	—	—	89.28	10	23
Minimum	—	—	86.17	0	0
U. S. Dept. Agr. approximation blown at 32, 34, 36 degrees	11	5[2]	89.39	0	0
Detailed purity blown at 32, 34, 36 degrees	12	5[2]	88.34	—	—

[1]Average (total) time to complete the ten tests by the modified referee method 21 minutes, for the U. S. Dept. Agriculture approximation 30 minutes.

[2]Five minutes included the actual blowing time and the time required to empty and adjust the blower between each degree of blowing.

TABLE 6.—*Comparison of results of repeated tests on the same working sample (Poa pratensis, No. 401508) by the U. S. Dept. Agriculture approximation and the referee approximation.*

	Percentage pure seed by[1]	
	U. S. Dept. Agr. approximation	Referee approximation
	%	%
	88.71	86.86
	88.43	87.38
	88.96	86.21
	88.94	86.78
	88.08	86.84
	88.36	86.45
	88.25	86.84
	88.94	87.23
	88.93	87.83
	88.78	86.60
Average	88.64	86.90
Average time	24 min.	21 min.
Standard deviation	.312	.447

[1]In the number of times that this sample was weighed, the weight varied but there was not a consistent loss or gain; the weight fluctuated with the atmospheric conditions. Detailed purity, 88.10%.

CONCLUSIONS

1. In the referee method, there was a wider variation in the purity percentage than in the U. S. Department of Agriculture approximation method, and there was no way to check on the cause of this variation.

2. One-minute blowing proved as effective as ten-minute blowing and gave a resulting purity that was nearer to the detailed purity than was the ten-minute blowing.

3. With the two bulks tried out, in the referee method, the lower the weight per bushel of a sample, the wider the variation in the purity results. In the U. S. Department of Agriculture approximation, there was very little variation in the purity results, regardless of the weight per bushel of the sample.

THE VALUE OF INCIDENTAL SEEDS FOUND IN SAMPLES OF COMMERCIAL SEEDS

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Frequently, a sample of seed comes into the laboratory of which knowledge of the origin is very desirable.

In 1934, large shipments of oats came into the United States from Argentina. The Department of Agriculture issued a statement that these oats were not well adapted to agricultural conditions in the United States, and consequently, were not desirable for seeding purposes. Since these oats closely resembled Red Rust Proof Oats, their origin could not be determined

by the appearance of the oat seed; therefore, the Division of Seed Investigations examined a number of these bulks for weed seed content. This examination showed that they not only carried a large number of weed seeds, but also some weed seeds that did not occur in the United States. These weed seeds were as follows:

Carduus macrocephalus
Carduus pycnocephalus
Nassella trichotoma
Oenothera indecora
Oenothera sp.
Panicum bergii
Brassica sp. (*B. campestris*)

Samples of white clover from Louisiana consistently carry weed seeds that are distinctive. The following are the most characteristic:

Serinia oppositifolia
Sisyrinchium sp.
Rudbeckia amplexicaulis
Ptilimnium capillaceum
Stachys agraria
Carex frankii

Likewise, the source of alfalfa seed from Southwestern United States can be determined by the following seeds:

Polygonum argyrocoleon
Trianthema portulacastrum
Chenopodium murale
Melilotus indica

In attempting to ascertain whether a sample of fine-leaved fescue is from Europe or New Zealand, the weed seed content combined with the appearance of the seeds themselves are used as a guide in expressing an opinion.

A small *Gramineae*; *Calamagrostis* sp. is found only in Festuca seed from New Zealand, while *Ornithopus sativus* is present in practically all samples of Festuca from Europe.

SHORT NOTE ON A NEW BLOWER

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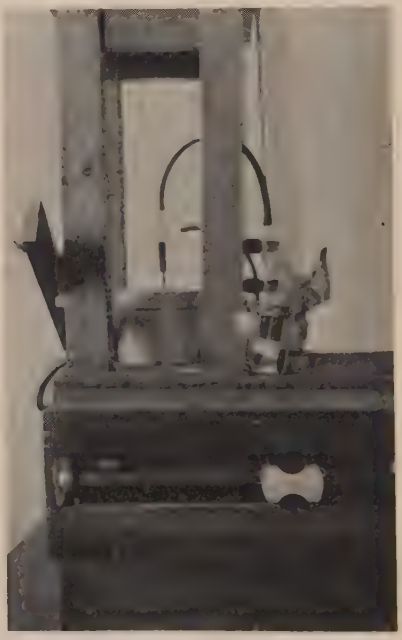
The Canadian Seed Laboratory Division is in the process of developing a new blower which has one or two distinctive features. It consists of a box with two major compartments. A vacuum cleaner unit is mounted on the dividing wall between the two compartments, thus creating a pressure in one side of the compartment and a vacuum in the other. By means of a sliding valve, air is admitted on the vacuum side and this serves to control the pressure developed on the pressure side. About 1½ inches from the top of the pressure compartment is a perforated baffle plate and air is drawn for blowing the seed from the top of the box above this.

We have used the old Kny-Sheerer glass tube and cylinder assembly. At a point close to the opening for the blower tube, is a take-off for a manometer, by means of which it is possible accurately to regulate the air-pressure. Repeated blowings on the same sample at the same pressure have shown a high degree of uniformity. The apparatus requires to be carefully watched, however, as the motor speed varies with fluctuations in voltage and with it, the pressure. It is felt that it is essential to employ a constant speed motor and possibly a voltage regulator. When this is done, an accurate control of the air column becomes possible.

FIGURES 1 AND 2. GENERAL ASSEMBLY OF BLOWER.



FIGURES 3 AND 4. CLOSE VIEWS OF THE CONTROL MECHANISM OF THE BLOWER.

The Figures 1 and 2 show the whole assembly and Figures 3 and 4 are close views of the control mechanism. It will be noted that a rheostat has been mounted to reduce the speed of the motor, but it is not used for the purpose of controlling the pressure. The small beaker was used in an attempt to overcome the effect of fluctuations in motor speed but without complete success.

VEGETABLE SEED TREATMENT EXPERIMENTS AND PRACTICES IN VIRGINIA

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Vegetable seed treatment for the control of seed borne diseases and for the prevention of seed decay after planting has been a subject of investigation for the last five years at the Virginia Truck Experiment Station and is now extensively practiced by growers and seedsmen of the State. In the Norfolk area alone, about 150,000 pounds of spinach seeds are treated annually; in Richmond two seed companies are treating a large proportion of their vegetable seeds, and throughout the State growers are either treating their own vegetable seeds or buying treated seeds.

The practice of treating seeds has spread rapidly in recent years because of the introduction of new materials and methods for treating and because of the increased realization of the benefits that are frequently derived from it. The rapid increase in the use of seed treatments has brought with it problems. In spite of the amount of experimental work that is now being conducted at the various experiment stations, there is relatively little information available on the comparative value of the various seed treatment materials that are being offered to the public and what is available is usually applicable to only a few kinds of seeds. There is also a lack of understanding on the part of some of the growers and seedsmen of the purpose of the various treatments and their place in the plant disease program. Treatment of seeds by the seedsmen has likewise created a problem for the seed testing laboratories, since certain treatments that are beneficial when the seeds are planted in soil may be harmful when they are germinated by the usual laboratory procedures.

Our experiments have been primarily concerned with treatments for the prevention of seed decay of spinach, since seed decay is an important problem with this important truck crop. Before the value of seed treatment had been demonstrated, our growers had difficulty, especially in the early fall plantings, in obtaining satisfactory stands. Now that spinach seed treatment has become an established practice, we seldom hear of failure to obtain a stand and when we do, the cause is usually traceable to failure to treat the seed or to the use of poor seed. The local seedsmen state that they formerly sold a large quantity of seed for replanting, but that since they have been treating seed, there is very little sold for that purpose.

Our first spinach seed treatment experiment was made in September 1932. Treatment with cuprous oxide and with copper sulphate solution resulted in increases of 243 and 333% in initial stand, 60 and 62% in stand after thinning, and 37 and 40% in yield as shown in Table 1. The benefits

were so striking that the growers began having their seed treated immediately with cuprous oxide, although we had made no recommendations on the basis of this single experiment. The results of our further experiments during 1932, 1933, and 1934 have already been published in bulletin 87 of the Virginia Truck Experiment Station. They demonstrated the value of zinc oxide and zinc hydroxide for treating seeds and contributed to the development of a commercial seed treating material (Vasco 4) having these two materials as the active ingredients. These experiments also demonstrated the need for improved experimental technique in order to satisfactorily determine the relative value of the various seed treatment materials.

TABLE 1.—*Beneficial effect of treating spinach seed with cuprous oxide and with copper sulphate in field trials.*

Treatment	Percentage increase over check		
	Stand		Yield
	Before thinning	After thinning	
Cuprous oxide	243	60	37
Copper sulphate	333	62	40

The methods developed and used in the experiments in 1935 and 1936 were as follows: The seeds were placed in a closed container with a definite percentage by weight of seed treatment material and were tumbled a uniform length of time to insure thorough coating of the seeds with the fungicide. Small quantities of seeds were treated in a small treating machine consisting of six pint fruit jars attached to a motor driven wheel. Larger quantities were treated in a hand turned barrel seed treater of the type commonly used for treating grains with copper carbonate.

The seeds were planted with a Planet Jr. horse drawn seed drill on five row raised beds in 1935 and with a Planet Jr. hand drill on single row beds in 1936. Several beds of each treatment were planted in each plot and a series of plots were planted from late in August until early in November. The seeds were weighed before placing them in the seed drill and the seeds remaining in the hopper after planting were weighed to determine the weight of seeds sown. The number of seeds in a gram was also determined so that the number sown in a foot of row could be calculated.

When the plants were up, the stand was determined by counting the number of plants in adjacent sections of the beds taken at measured intervals down the field. The sections were either three or six feet long and from 10 to 25 were counted for each treatment in each plot. In the case of the five row beds, only the center three rows were counted. The actual stand was converted to percentage stand on the basis of the number of seeds sown in each treatment. The data were then treated statistically by Fisher's method for the analysis of variance, considering each section of bed as a replication.

Table 2 shows the data from the experiments on the relative value of cuprous oxide, zinc oxide, and Vasco 4 used at the rates of 1, 1.5, and 2%. In Plot 4, only 2% cuprous oxide gave better results than the check, indicating that seed decay was not important at the time this plot was planted.

In plots 1, 2, and 3, all treatments were better than the check, but the differences between the treatments were either slight or none.

TABLE 2.—*Comparison of cuprous oxide, zinc oxide, and Vasco 4*

Treatment	Percentage stand			
	Plot 1	Plot 2	Plot 3	Plot 4
Cuprous oxide—1.0%	36	44	57	66
Cuprous oxide—1.5%	37	54	56	68
Cuprous oxide—2.0%	46	53	62	76
Zinc oxide—1.0%	37	43	56	64
Zinc oxide—1.5%	33	47	59	72
Zinc oxide—2.0%	37	41	60	66
Vasco 4—1.0%	40	46	55	64
Vasco 4—1.5%	32	50	60	66
Vasco 4—2.0%	32	46	59	65
Check	19	19	37	67
Significant differences	7	5	4	7

Table 3 shows the relative values of New Improved Ceresan, Semesan, and cuprous oxide. The Ceresan and Semesan were used at the rates recommended by the manufacturer.

The data indicate that New Improved Ceresan is a promising material and that Semesan is inferior to New Improved Ceresan and cuprous oxide.

TABLE 3.—*Comparison of New Improved Ceresan, Semesan, and Cuprous oxide.*

Treatment	Percentage stand			
	Plot 1	Plot 2	Plot 3	Plot 4
Cuprous oxide—2.0%	46	53	62	76
Ceresan—0.1%	37	51	53	77
Semesan—0.3%	30	37	49	65
Check	19	19	37	67
Significant differences	7	5	4	7

Table 4 gives the data for copper oxychloride, Fungex (a commercial copper fungicide), cuprous oxide, and the check. These data indicate that copper oxychloride has possibilities as a seed treatment material while Fungex appears to be definitely inferior.

TABLE 4.—*Comparison of copper oxychloride, Fungex, and cuprous oxide.*

Treatment	Percentage stand		
	Plot 1	Plot 2	Plot 3
Cuprous oxide—2.0%	53	58	82
Copper oxychloride—2.0%	47	50	58
Fungex—2.0%	37	55	47
Check	18	56	39
Significant differences	5	—[1]	10

[1]Differences not significant.

Table 5 gives data on the comparative value of four grades and brands of zinc oxide and Vasco 4. All of these materials caused increases in stand over the checks, except in Plot 4, but no one material was consistently superior to the others.

TABLE 5.—*Comparative value of four grades and brands of zinc oxide and Vasco 4.*

Treatment	Percentage stand			
	Plot 1	Plot 2	Plot 3	Plot 4
Zinc oxide-Tech.—1.5%	33	47	59	72
Zinc oxide-Pure—1.5%	33	52	58	68
Zinc oxide-Leafox—1.5%	34	52	56	60
Zinc oxide-AAZ Special—1.5%	36	48	60	66
Vasco 4—1.5%	32	50	59	66
Check	19	19	37	67
Significant differences	7	5	4	7

Table 6 shows the relative values of cuprous oxide when used at the rates of 0.5, 1.0, 1.5, 2.0, and 4.0%. The data for Plot 2 were not significant. In Plot 1, the rate 0.5% was not as effective as the larger amounts, but there were no differences between any of the higher rates. In Plot 3, the 0.5 and 1.0% rates were not as effective as the higher rates. There were no differences between the 1.5, 2.0, and 4.0% rates.

TABLE 6.—*Relative value of cuprous oxide when used at varying rates*

Treatment	Percentage stand		
	Plot 1	Plot 2	Plot 3
Cuprous oxide—0.5%	41	55	63
Cuprous oxide—1.0%	50	54	65
Cuprous oxide—1.5%	50	53	82
Cuprous oxide—2.0%	54	58	82
Cuprous oxide—4.0%	54	53	82
Check	18	56	39
Significant differences	5	—[1]	10

[1]Differences not significant.

Table 7 shows the relative values of zinc oxide when used at the rates of 0.5, 1.0, 1.5, 2.0, and 4.0%. In Plot 1, there was no increase in effectiveness of the treatments above 2.0%, and in Plot 3, only the 4.0% rate was superior to the 0.5% rate. Similar results were obtained with Vasco 4 at the same rates.

From the data of the last two tables, it appears that between 1 and 2% will give the maximum results under average conditions. When large quantities of seeds are being treated, it is, therefore, suggested that these fungicides be used at the rate of 1.5%. When small amounts of seed are being treated, however, it is advisable to use 2.0% because mixing is not as thorough and some of the dusts stick to the container in which the treating is done.

TABLE 7.—*Relative value of zinc oxide when used at varying rates.*

Treatment	Percentage stand		
	Plot 1	Plot 2	Plot 3
Zinc oxide—0.5%	34	58	65
Zinc oxide—1.0%	38	55	71
Zinc oxide—1.5%	42	52	69
Zinc oxide—2.0%	49	58	72
Zinc oxide—4.0%	48	52	75
Check	18	56	39
Significant differences	5	—[1]	10

[1]Differences not significant.

Table 8 gives data on the comparative value of a mixture of zinc oxide and cuprous oxide with plain zinc oxide and cuprous oxide. Seed decay was not important in Plot 4, as is indicated by the excellent stand in the check. In the other three plots, all of the materials caused increases in stand over the checks and in no case did the mixture cause increases in stand over either material when used alone. These data indicate that both materials were equally effective against the decay organisms that were involved.

TABLE 8.—*Value of a mixture of zinc oxide and cuprous oxide as compared with either ingredient used separately.*

Treatment	Percentage stand			
	Plot 1	Plot 2	Plot 3	Plot 4
Zinc oxide—0.75% and Cuprous oxide—0.75%	38	43	56	79
Zinc oxide—1.5%	33	47	59	72
Cuprous oxide—1.5%	37	54	56	68
Check	19	19	37	67
Significant differences	7	5	4	7

Experiments with graphite added to the treatment at the rates of ¼ and ½ the amount of fungicide used, showed that graphite did not influence the effectiveness of the fungicide or the germination of the seeds. It was not necessary for protecting the seeds from mechanical damage as a result of friction, but it did reduce the wear and breakage of the seed drill. A mixture of Vasco 4 and graphite was used by the growers at Norfolk last year with excellent results.

Cabbage seed treatment has not been as extensively investigated as has spinach, but some interesting information is available. The results of the tests in 1936 are shown in Table 9. The same methods were used for treating, planting and taking the records in the field tests as were used for the spinach experiments. In the greenhouse tests, a weighed amount of the seeds that had been used in the seed drill in the field were planted in rows in flats. The data for the field experiment are not very conclusive because of damage to the plot by heavy rains. They do, however, show a somewhat better stand from the various treatments in combination with graphite and from Semesan than was obtained from the check or the treatments without

graphite. The same seed planted in the greenhouse showed a decrease in stand as compared for the zinc oxide and Vasco 4 treated seeds, no significant increase from cuprous oxide treatment, and an increase from Semesan when used without graphite. When graphite was used with the fungicides, large increases were obtained with all of the treatments over the checks and the corresponding treatments without graphite, except Semesan, in which only the increase over the check was significant. These results are correlated with the amount of seed injury as illustrated by the number of uncracked seeds in each lot. This emphasizes the necessity of using graphite with the fungicides when treating cabbage or similar seeds, in order to avoid injury from friction. The addition of graphite appeared to aid in making a more even coating of the fungicides on the seeds as well as to act as a lubricant.

TABLE 9.—*Comparison of various fungicides in the treatment of cabbage seed in 1930.*

Treatment	Percentage stand		Number of uncracked seeds in two grams
	Field test	Greenhouse test	
Check (untreated)	39.8	38.8	545
Zinc oxide	37.1	13.2	393
Cuprous oxide	36.0	47.8	497
Vasco 4	42.6	16.7	245
Semesan	49.8	70.5	—[1]
Graphite	48.6	46.4	520
Zinc oxide and graphite	52.7	81.2	510
Cuprous oxide and graphite	53.1	68.2	532
Vasco 4 and graphite	50.9	79.3	529
Semesan and graphite	52.6	78.3	535
Significant differences	8.0	10.0	—

[1] Seed lost before count was made.

Our tomato seed treatment experiments are not far enough along to warrant drawing definite conclusions on the relative merits of the various materials. They indicate, however, that copper oxychloride, zinc oxide, Vasco 4, cuprous oxide, and copper sulphate solution will give worth-while increases in stand in open seed beds. Increases from treatment of over 100% in stand over the checks have not been uncommon in our experiments. Graphite was not found to be of any value with treated tomato seeds.

We have made only preliminary experiments thus far on seed treatments for the control of seed borne diseases, but a considerable amount of tomato, cabbage, kale, and cucurbit seeds have been treated for various growers according to the usual recommendations found in the literature. In these cases, we generally used the more severe treatments that have been recommended and did not observe any appreciable reduction in germination in the tests.

On the basis of our experiments and observations on seed treatments and the general recommendations in the literature, a vegetable seed treatment chart has been prepared and is available to seedsmen and farmers in Virginia. In this chart the stronger treatments are recommended, since we believe that it is desirable to use treatments that will destroy the pathogenic bacteria and spores even at the risk of some injury to the seeds. For instance, since our investigations indicate that soaking tomato seeds for five minutes

in 1–3,000 bichloride of mercury solution, as is recommended in most States, is not effective in disinfecting the seeds, we recommend soaking seven minutes in a 1–2,000 solution. This treatment has proved satisfactory both when used by seedsmen and growers in Virginia. Treatment with one of the dust fungicides, such as cuprous oxide or zinc oxide, is also suggested after the seeds have been treated with bichloride of mercury and dried.

Seed treatment is given an important place in the disease control program recommended for many crops. We feel that it is one of the most effective, practical and cheapest disease control measures.

At the present time, the disinfection of vegetable seeds with bichloride of mercury is complicated by the various solutions and lengths of treatments that are recommended. Strengths of from 1–1,000 to 1–3,000 and periods of from 5 to 30 minutes are recommended. One of the aims of our experiments is to attempt to simplify these recommendations so that they will be less confusing.

At the present time, seeds are being treated by both growers and seedsmen. Some seedsmen seem to have a good understanding of the principles of seed treatment and are following a definite program that will afford the growers the maximum benefit that can be obtained in the control of seed-borne diseases and the prevention of seed decay in the soil. Other seedsmen, however, are using seed treatment as a selling point, but apparently have very little appreciation of the principles involved, and are not applying treatments that are of the most value to the farmer. For instance, two farmers, who had been advised to treat their cucurbit seed with bichloride of mercury for anthracnose, bought seed that had been treated only with a zinc dust for the prevention of seed decay because the seedsmen advised them that his seed had been treated to prevent disease.

Because of the various methods and materials recommended for treating seeds, it would be advisable for the seedsmen to be required to label their seeds with the kind of treatment that has been applied. This would enable the grower or county agent to tell whether or not the seeds had been treated according to the recommendations of their Experiment Station, and the seed testing laboratory would be able to handle the seeds and interpret the results of their germination tests better. It would also avoid possible injury to seed by the grower retreating seed that had already been treated.

THE PATHOGENICITY OF *FUSARIUM* SPP. IN COMMERCIAL PEA SEED[1]

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In any discussion of the diseases of peas, *Fusarium* spp. figure prominently as the causal organism. For example, a recent publication, "Pea diseases and their control", includes descriptions of three diseases caused by species of Fusarium. Brown and Evans (1)[2] in "Diseases of Peas in Arizona" call attention to a new disease known as "foot rot" caused by *Fusarium merismoides.* Not all of these species when isolated from the tissues or surfaces of pea plants were noticeably pathogenic.

Literature Review

In a survey of pea diseases in New Jersey, Haensler (4) isolated 11 strains of *Fusarium,* but only one of them was found to be pathogenic. Jones (7) believed that *Fusarium martii pisi* was the only parasitic species of the many *Fusarium* spp., which he had isolated, which was not seed-borne. *F. vasinfectum pisi, F. falcatum, F. viticola, F. orthoceras, F. redolens,* and *F. oxysporum,* although stated to occur in diseased pea plants by other workers, did not appear pathogenic in the examination by Jones. While studying the *Ascochyta* complex in New York, L. K. Jones (6) commonly isolated *Fusarium* spp. from infected seeds. He also observed *Fusarium* spp. associated with the seeds in Washington, but believed that most of these were non-pathogenic. Kadow and Jones (8) studied a wilt of peas, paying special attention to seed dissemination of the causal organism, *Fusarium orthoceras pisi.* They planted 5,000 seeds from a badly infested field, and then pulled the plants after 25 days' growth and replanted the area with surface sterilized Alaska pea seeds. No wilt developed in this second crop, but one center of wilt was found in a third crop, and also in a fourth crop. Further experiments indicated that this species did not enter the seed from the diseased plant, but that it may have established itself in seeds which came in contact with contaminated soil. External seed carriage appeared to be a more common method of dissemination. Snyder (10) reported seed transmission of the wilt-organism but wilting did not occur until four series of peas were sown in a restricted area. Moore (9) isolated a foot-rotting species from disease plants and succeeded in obtaining the typical disease by planting seed which had been dipped in a spore suspension.

From this review of the literature, it is apparent that (1) seed transmission of pathogenic species of *Fusarium* does occur but it is rare, (2) seed carriage is largely external, (3) nonpathogenic species are also seed-borne, (4) the wilt organism, after its introduction into the soil from seeds,

[1]Approved by the Director of the New York State Agricultural Experiment Station for publication as Journal Paper No. 215.

[2]Numbers in parenthesis refer to Literature Cited.

causes no disease until after a period of several months to a year, and (5) inoculations by spore suspension on the seed are successful in root-rot studies.

EXPERIMENTAL WORK

Previous reports before this Association by Crosier (2, 3) have indicated that pea seed *Fusarium* spp., associations are quite common. The percentage of contaminated samples have varied widely with the growing season and the source of the seed. Only 0.6% of the seedstock received in 1932 were infected, nearly 7% of the pea lots tested in 1933 contained *Fusarium* infected seed, about 2.2% in 1934, 2.9% in 1935, 1.1% in 1936, and 1.4% in 1937. Many of the infected seeds were surface sterilized and placed on sterile agar, yet growths of *Fusarium* developed in every attempt at isolation. This proved that the fungi establish themselves internally. Surface sterilization studies with dry seeds taken directly from the seed growers' packages indicated further that establishment of these fungi occurred during maturation of the seed.

Examination of paper roll tests of germination of peas has revealed the pathogenicity of these fungi. Commonly, the plumules adjacent to the infected seed are rotted, and often completely destroyed. Radicles may be withered at the tips, rotted off, discolored, or marked by small necrotic areas. The hyphae occasionally grow so rapidly and profusely that most of the seedlings are affected and germination readings can not be made.

In several experiments, both plumules and radicles of healthy seedlings were placed on the *Fusarium*-covered seeds. All degrees of rotting were observed. Simply inserting the pieces of mycelium into the plumules, provided sufficient inoculum for extensive rotting. For a comparison of the pathogenicity of several fungi, hyphal masses from pure cultures were inserted into plumules of seven-day old seedlings. One isolation destroyed five plumules, and caused definite spots in the other seven cases. Another isolation killed five plumules at the point of attachment while another plumule was rotted off and seven others were discolored and marked with small necrotic areas.

The strains which caused the greatest injury in the germinators originated in Western United States seedstocks. Almost invariably, the hyphae on viable seeds were capable of inducing both plumule and radicle decay. On the other hand, peas harvested in New York and Ontario have been found to contain 10 to 15% of dead seeds which were infested with *Fusarium* spp., *Alternaria* sp., and *Rhizopus nigricans*. None of these strains of *Fusarium* spp. were pathogenic. Inoculating pea seedlings under aseptic conditions, also showed that rotting could be caused by the western strains. Usually, infections were common to the growing tips of the plumules, less often the plumules were rotted into, while occasionally hyphae extended the entire length of the plumule. These observations indicate that pathogenic *Fusarium* spp., are seed-transmissible and are common only to regions where the wilt disease is prevalent. The symptoms, however, are those of rotting, not wilting; inferential evidence that the wilt organism is not concerned.

Greenhouse studies substantiated this evidence to some extent while they discredited a definite pathogenicity of any kind. Reference to results obtained in 1935 and 1936 bears out this contention. Although significant reductions in soil emergence occurred, no wilting was noted and, furthermore, a second planting in the same pots showed only a trace of rotting

and no wilting. A number of isolations from pea seeds were made in 1937, and from these 27 *Fusarium* spp., together with strains of *Alternaria* sp., bacteria, *Rhizoctonia solani*, and *Ascochyta pinodella*, were selected for greenhouse studies. The organisms were increased on sterilized wheat grains in 500 c.c. flasks. Pots were filled to within 1½ inch of the top with pasteurized soil, 10 seeds each of the Thomas Laxton, Perfection, Surprise, Wyoming Wonder, and copper-treated Telephone varieties were spaced over the surface. A half-inch depth layer of the wheat grains was added and the soil was packed on top. The results in Tables 1 and 2 are based on numbers of emerged seedlings in 24 days after planting and green weights of tops of seedlings cut at the soil level 35 days after planting. Obviously, the ability to cause seed decay varied with each strain. A few were nearly as injurious as the culture of *Rhizoctonia solani* while six other strains did not effect significant decreases in greenhouse stand. The green weights of the tops did not suggest wilting. The average of all the seedlings in the Fusarium contaminated pots was 4.15 as compared to 4.89 for soil with sterilized wheat grains and 5.53 for pasteurized soil with no grains added. There were only slight differences in the plants growing in any one pot and, furthermore, the average weight of the plants in all five pots of any one strain closely approximated the average of 4.15.

TABLE 1.—*Influence of Fusarium spp. and of other organisms, isolated from pea seeds, on the soil-emergence of seedlings and on the green weight of the tops.*

Varieties of peas	Fusarium[1]	Alternaria[2]	Ascochyta	Rizoctonia	Bacteria	Check with wheat grains[3]	Check without wheat grains
	Number Seedlings Emerged Per Pot:						
Perfection	6	6	9	1	10	8	10
Thomas Laxton	7	7	10	1	10	10	10
Surprise	5	7	7	1	10	8	10
Wyoming Wonder	6	6	6	0	8	9	10
Telephone	6	7	7	0	6	8	10
Average	6.0	6.6	7.8	0.6	8.8	8.6	10.0
	Green Weight of Tops Per Pot in Grams:						
Perfection	23.2	25.6	4.2	9.0	49.4	43.2	60.2
Thomas Laxton	30.1	36.4	15.8	6.2	48.0	56.2	75.8
Surprise	19.1	21.2	10.1	0.2	25.2	35.2	34.9
Wyoming Wonder	22.0	25.7	5.0	0.0	37.9	42.1	68.0
Telephone	27.6	32.2	15.1	0.0	34.9	44.6	43.4
Average	24.4	28.2	10.0	3.1	39.1	44.3	56.5

[1]Averages of 27 trials.
[2]Averages of four trials.
[3]Averages of three trials.

TABLE 2.—*Relation of Fusarium spp. and of other organisms to soil emergence and to green weight of tops of peas.*

Varieties of peas	Fusarium	Alternaria	Ascochyta	Rhizoctonia	Bacteria	Check with wheat grains	Check without wheat grains
	Percentage Emergence in Soil:						
Perfection	56	58	90	10	100	70	100
Thomas Laxton	68	73	100	10	100	95	100
Surprise	46	70	70	10	100	75	100
Wyoming Wonder	57	58	60	0	80	90	100
Telephone	57	68	70	0	60	85	90
Average	57	65	78	6	88	83	98
	Weight of Tops per Pot in Grams:						
Perfection	22.3	25.6	4.2	9.0	49.4	42.8	52.1
Thomas Laxton	30.6	36.4	15.8	6.2	48.0	55.3	66.9
Surprise	16.6	21.2	10.1	0.2	25.2	31.6	38.6
Wyoming Wonder	20.7	25.7	5.0	0.0	37.9	37.5	59.6
Telephone	27.2	32.2	15.1	0.0	34.9	35.3	53.5
Average	23.7	28.2	10.4	3.1	39.1	50.4	54.1
	Weight of Tops per Seedling in Grams:						
Perfection	3.98	4.45	0.47	9.00	4.94	6.11	5.21
Thomas Laxton	4.50	5.20	1.58	6.20	4.80	5.81	6.69
Surprise	3.74	3.29	1.44	0.20	2.52	4.21	3.86
Wyoming Wonder	3.63	4.47	0.83	——	4.74	4.17	5.96
Telephone	4.95	4.77	2.16	——	5.82	4.15	5.94
Average	4.15	4.42	1.48	5.13	4.56	4.89	5.53

Peas of the varieties Alaska, Climax, Surprise, Telephone, and Wisconsin Early Sweet were planted immediately after the first experiment was concluded. Using sterilized dibbles, 20 seeds were inserted in each pot at the level of the wheat grains. This second crop was counted, cut, and weighed 26 days after planting. The results are comprised in Table 3, the order of the strains being the same as in Table 1. It is at once apparent that only six of the *Fusarium* cultures depressed the emergence as compared to the control pots with sterilized wheat grains. The average is slightly higher. This is probably due to the accumulation of root-rotting organisms in the control pots, to the decrease in concentration of *Fusarium* mycelium in the test pots, and also to the more obvious reason that many of the seeds were not placed in contact with the inoculum at all. It is certain that the *Fusarium* spp. common to pea seeds are not aggressive pathogenes, that they cause no wilt, and that they effect a root-rot or seed decay only when the mycelium is extremely concentrated and free from other organisms.

TABLE 3.—*Relation of fungous seed-associates to emergence and to development of five varieties of canning peas.*

Varieties of peas	Fusarium[1]	Alternaria[2]	Ascochyta	Rhizoctonia	Bacteria	Check with wheat[3]	Check without wheat[3]
	Number Seedlings Emerged Per Pot:						
Alaska	17	16	19	10	20	18	19
Climax	16	15	18	5	15	18	17
Surprise	14	14	17	3	10	11	17
Telephone	14	16	14	9	18	15	18
W. E. Sweet	15	19	18	7	17	16	16
Averages	15.5	16.0	17.5	6.8	16.0	15.6	17.4
	Green Weight of Tops Per Pot in Grams						
Alaska	33.7	35.6	28.9	22.2	33.1	30.5	31.8
Climax	33.2	35.2	35.3	6.5	22.0	33.7	27.2
Surprise	30.6	35.4	26.9	21.8	33.0	23.5	25.3
Telephone	34.6	42.5	36.3	9.5	29.7	33.9	30.6
W. E. Sweet	30.2	39.7	34.0	20.7	31.5	31.9	28.6
Averages	32.5	37.7	32.3	16.1	29.9	30.7	28.7

[1]Averages of 27 trials.
[2]Averages of four trials.
[3]Averages of two trials.

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THE VALUE OF CHEMICAL SEED TREATMENTS IN GERMINATION STUDIES[1]

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Recent studies have emphasized the value of chemical seed treatment in laboratory germination work. It may not be evident, however, that certain chemicals are more effective than others in fungous elimination or safer for general laboratory technique. Porter (2) has stated his preference for their application as dusts. Crosier et al (3) have developed a faster, more economical, and safer method for applying any material which can be dissolved or easily suspended in water.

It is well to bear in mind that the larger agricultural seeds such as beans, corn, lima beans, peas, and soybeans, have been the most generally used test subjects. These seeds are carriers of several profuse-type fungi and also of soft-rotting bacteria. If for any reason germination is delayed, or especially if a number of dead seeds are present, these micro-organisms develop upon the nutrients of the dead or decadent seeds and spread over the normal seedlings. The dense growth of mycelium acts as a mechanical barrier by obscuring the seedlings from view and, therefore, both increases the time needed for reading the tests and decreases the accuracy of the reading. The organisms may, and commonly do, attack the live seeds and developing seedlings, often rotting them completely and increasing the difficulty of determining the percentage of strong seedlings.

Therefore, an effective chemical must protect the seedlings as well as eliminate the associated micro-organisms. Perhaps isolate or localize better expresses this idea. For example: If 10 dead and contaminated seeds of peas are mixed with 90 normally viable seeds, the expected germination is 90%. Without chemical protection, the organisms for the 10 dead seeds will injure or destroy a number of the viable seeds or their developing seedlings resulting in a reading of 80%, or possibly lower. If a material is so used that each of the 90 seeds has a protective barrier, they are then isolated chemically from contaminated seeds and will develop normally even though mycelium arising from the dead seeds may overrun them. But if all of the seeds are covered, and naturally this is the usual technique, the organisms are inhibited or eliminated so that a clean, easily readable test is secured showing 90 strong seedlings and 10 dead contaminated seeds.

A few recent tests of peas will illustrate this point. Duplicated rolls of 100 untreated seeds each gave percentages of 54, 70, 72, 67, and 72. In every roll, molds were very profuse and had penetrated the toweling and reached the adjacent rolls of treated seeds. The seeds from the same samples were

[1]Approved by the Director of the New York State Agricultural Experiment Station for publication as Journal Paper No. 214.

[2]Porter, R. H. Relation of seed disinfectants to seed analysis. Proc. Assn. Off. Seed Analysts North America. *1936:* 93–101. 1936.

[3]Crosier, Willard, Patrick Stewart, and Taylor, Lloyd. Chemical treatments helpful in germination tests of seeds. Phytopath. *27:* 797–798. 1937.

TABLE I.—*Relation of New Improved Ceresan and mercuric chloride to germination, fungus growth, bacterial growth, and to weight of pea seedlings*

Test No.	Germination			Fungus growth			Bacterial growth			Weight of seedlings		
	Check	N. I. C.	M. C.	Check	N. I. C.	M. C.	Check	N. I. C.	M. C.	Check	N. I. C.	M. C.
	%	%	%	%	%	%	%	%	%	Grms.	Grms.	Grms.
1	72	85	84	80	0	0	20	14	15	82	78	79
2	99	97	99	27	0	0	2	0	0	85	87	88
3	78	85	77	31	0	0	22	0	19	100	94	95
4	33	44	54	100	0	1	61	49	43	88	86	87
5	77	90	87	26	0	2	15	10	8	87	93	94
6	84	85	86	9	0	2	4	14	12	90	90	87
7	91	92	89	14	0	0	6	5	9	91	92	87
8	80	94	93	27	0	0	20	2	5	92	98	104
9	82	87	88	0	1	0	15	10	10	108	117	114
10	88	99	96	42	0	0	10	0	2	101	108	112
11	79	82	86	30	0	0	10	0	2	93	109	109
12	82	87	76	32	0	1	14	5	15	74	75	69
13	93	97	94	4	0	0	4	0	0	108	111	108
14	89	93	85	69	1	2	6	2	5	101	121	113
15	95	90	93	20	0	0	3	1	0	98	95	88
16	92	90	96	54	1	0	3	5	0	118	108	112
17	93	98	95	12	2	3	3	1	5	116	115	118
18	80	93	82	100	0	0	20	3	10	66	78	78
19	65	96	87	81	0	1	10	3	3	90	116	109
20	87	93	96	42	0	0	13	0	0	118	122	127
Average	81	89	87	40	.25	.60	13.1	6.2	8.15	95.1	99.7	99.0

[1]Untreated seeds taken from packets and placed on towels.
[2]New Improved Ceresan suspended in water at a dosage of 0.15% or a concentration of 0.0045% of ethyl mercuric phosphate.
[3]Mercuric chloride in aqueous solution of 0.15%.

treated by an instant dip in ethyl mercuric chloride and placed in paper rolls in contact with the untreated rolls. The percentages of germination were respectively, 84, 92, 95, 85, and 78 or increases of 6% to 30% with an average of 19.8%.

The ideal chemical must control the seed-associated micro-organisms while displaying no phytotoxicity at the lethal fungicidal dosage. A number of recent comparisons of untreated, New Improved Ceresan, and mercuric chloride treated peas are assembled in Table 1. Both of the chemicals were applied as dips at a concentration of 0.15%. The seeds were germinated in paper rolls at 20°C.

The data bear out these general findings for the mercury compounds; (1) the apparent number of normal sprouts in severely contaminated samples is increased by seed treatments, (2) the germination of nearly-clean, strong seed is little affected by chemicals, (3) fungous growths are practically eliminated, (4) bacteria are localized at the point of origin but bacterial soft-rot of dead or decadent seeds cannot be prevented, and (5) the total weight of the seedlings is increased slightly, indicating that the correct dosages of New Improved Ceresan and mercuric chloride do not injure the seedlings of peas.

Not all materials are so ideal for treatment of peas. They are very intolerant of the copper and zinc ions and the pea radicles are easily injured. The results of several experiments conducted in 1935 are given in Table 2. All of the materials were applied as dusts. New Improved Ceresan was mixed with five times its bulk of copper stearate, to make a combination copper-mercury dust. The others were used exactly as received from the manufacturers. The peas were counted in hundreds, placed in flasks, the dust added, and the contents shaken vigorously. Excess dust was removed by pouring the seeds into a wire test tube basket and shaking gently. Since the samples were very contaminated, significant increases in apparent germination were obtained. That elimination of fungi allows better growth is proven by the weights of the detached seedlings.

Typical copper or zinc injury of peas is expressed by radicle malformations or killing. The plumules are not affected to any great extent. The decreased lengths of the plumules as compared to the controls in Table 2 are due largely to differences in physiological age. The mixture made up of 4 parts of copper stearate and one part N. I. Ceresan dust did not prove satisfactory, but later experiments with a mixture made of 20 parts copper stearate, 4 parts inert dust and 1 part N. I. Ceresan were very successful. Copper stearate alone produces less injury than copper carbonate or cuprous oxide although nearly three times as much bulk of copper stearate will adhere to pea seeds.

The combination of four parts copper stearate with one part of N. I. Ceresan simply allowed three times the usual dosage of the latter to adhere to the seeds. The typical form of mercury poisoning is expressed by marked stunting and often a thickening or clubbing of both radicles and plumules. Such injury is indicated by the measurements of the copper stearate-N. I. Ceresan seedlings in Table 2.

That copper stearate and N. I. Ceresan used alone are not injurious, is proven by the data in Table 3. The samples used in this experiment had been very difficult to read when the seed was not treated. By applying any of the chemicals listed in Table 3, the associated fungi were practically eliminated.

TABLE 2.—*Effect of various materials on peas as shown by germination, development of micro-organisms, and growth of seedlings—Average of 31 lots.*

Material used as a dust	Strong sprouts	Contaminated seeds[1]	Weight of 100 sprouts	Length of plumules		Length of radicles		Chemically-injured tests
				Max.	Aver.	Max.	Aver.	
	%	%	gms.	cms.	cms.	cms.	cms.	no.
Ceresan	91.5	.3	74.2	3.61	2.78	4.05	2.57	1
Copper Stearate and N. I. Ceresan	84.3	.2	35.7	1.36	.79	1.65	.93	25
Copper carbonate	84.1	.9	49.9	3.38	2.20	2.19	1.16	20
Cuprous oxide	87.3	.9	53.4	3.08	1.88	1.99	.97	25
Zinc oxide	85.6	4.4	46.7	3.13	1.90	1.99	.89	29
Control	71.1	39.7	41.3	3.55	2.30	3.13	1.72	—

[1]Seeds contaminated with fungous growths.

TABLE 3.—*Influence of various materials on peas as shown by germination, development of seedlings, and micro-organisms;—average of 15 lots.*

Material used	Strong sprouts	Contaminated seeds[1]	Length of plumules		Length of radicles		Chemically-injured tests
			Max.	Aver.	Max.	Aver.	
	%	%	In.	In.	In.	In.	no.
N. I. Ceresan	94.7	1.1	2.7	1.81	3.50	2.15	2
Cuprous oxide	92.3	.81	2.21	1.42	1.73	.85	15
Copper stearate	94.9	.52	2.38	1.74	3.00	1.79	2
Copper sulfate	89.1	2.31	2.36	1.50	2.48	1.20	12
Zinc oxide	90.7	1.50	2.29	1.29	2.07	.92	15
Control	56.3	52.5	2.13	1.25	2.73	1.37	0

[1]Seeds contaminated with fungus.

Greenhouse tests showed that the average soil emergence was approximately 90%.

Seed treatments are of value in germination studies of smaller seeds. A number of untreated onion tests were completely overrun with molds and later the gemination of untreated, N. I. Ceresan-dusted, N. I. Ceresan-dipped and diluted cuprous oxide-dusted seeds were compared. A suspension of 0.20% N. I. Ceresan was used which is stronger than has now been found necessary or advisable. Slight, but not serious, mercury injury was observed accompanied by some reduction in percentage of normal sprouts. The results assembled in Table 4 indicate that the dust method is more satisfactory than the dip method and that N. I. Ceresan is slightly better than diluted cuprous oxide in respect to germination.

Cabbage, morning glory, sweet peas, salsify, cucumber, and muskmelon have been benefited by both dust and dip treatments. The mercury compounds have increased the germination slightly more than have the copper compounds but in general both have been very satisfactory. It has been found advisable to use an 0.18% suspension, or a 1-part chemical and 5-parts inert dust dilution of N. I. Ceresan. Cuprous oxide used as manufactured, gives much better fungus control than the diluted dust, but occasionally injures

TABLE 4.—*Influence of New Improved Ceresan and cuprous oxide on germination of, and fungous growths on onion seeds*

Sample No.	Normal seedlings				Seedlings contaminated with fungi			
	Untreated	N. I. C. dust	N. I. C. dip	Cuprous oxide	Untreated	N. I. C. dust	N. I. C. dip	Cuprous oxide
	%	%	%	%	%	%	%	%
830	61	62	51	50	14	0	0	5
831	8	17	12	6	100	0	0	10
832	66	70	60	66	12	0	0	5
833	69	70	56	65	6	0	0	0
834	31	30	23	31	15	1	0	2
835	38	46	38	45	100	3	0	65
836	65	64	60	62	20	0	0	4
837	30	44	46	38	10	3	0	3
838	41	41	29	43	2	1	0	2
839	84	81	68	84	0	0	0	0
840	66	65	71	60	4	3	0	1
920	95	97	94	97	5	0	0	0
921	33	43	26	29	16	2	0	7
922	98	94	96	88	0	0	0	0
923	64	71	71	62	100	0	1	53
Average	56.6	59.7	53.4	55.1	26.9	.9	.1	10.4

even the smaller seeds. Preliminary treatments of any particular seed will demonstrate whether or not it is tolerant of cuprous oxide or if dilution is necessary.

GERMINATION OF TREATED AND UNTREATED PEA SEEDS IN AUTOCLAVED AND UNAUTOCLAVED SOIL[1]

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Many diseases of peas have been recorded and the presence and significance of organisms associated with the seeds have received considerable attention. Since Orton's (8)[2] record of the important seed-borne pathogens, in which he listed five pathogenic fungi, one saprophytic fungus, four bacteria, and one virus associated with peas, reports have been made of other pea seed associates. The associations of various pathogenic species of fungi with pea seed have been cited by Snyder (10), Jones (6), Kadow and Jones (7), Brown and Evans (1), and Crosier (2, 3). Recent bulletins by Harter, et al. (5) and Brown and Evans 1) contain discussions on the control of pea diseases. More recently, Crosier (4) has given attention to the prevalence and significance of fungus associates of pea seeds, and Porter (9) obtained significant increases in field germination of Perfection peas by treating the seed with Semesan Jr., Sterocide, Ceresan, and Merko.

Undoubtedly, the presence or absence of seed-borne or soil-borne pathogens exerts a decided effect on the germination of a given lot of seed. Since

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[2]Numbers in parenthesis refer to Literature Cited.

one of the most important functions of a seed laboratory is to determine as accurately as possible the value of a given lot of seed for sowing, it seems desirable that information should be obtained showing the effect of different substrata on seed germination. The control of seed-borne pathogens which might impair the germination of a given lot of seed and a knowledge of the effect of the medium used for the germination test seem as desirable as the consideration of proper conditions of temperature and moisture. The studies reported in this paper deal with the germination of pea seeds with special attention to seed treatment and the medium for germination.

MATERIALS AND METHODS

Two lots of Alaska pea seed were selected for the germination tests. Lot No. 1 contained a high percentage of diseased seed, while Lot No. 2 consisted of nearly disease free seed obtained from Idaho. Germinations were made in copper sand pans 6 x 12 x 1½ inches, 100 seeds to each pan. Autoclaved or unautoclaved greenhouse compost was used for the substrata and germinations were made in thermostatically controlled incubators at three different temperatures, namely 20°, 15°, and 10°C. The effect of six different treatments, including bichloride of mercury 1–500, copper oxychloride, cuprocide, Formafume, Ceresan, and 1% ethyl mercury phosphate, were compared throughout the experiment.

EXPERIMENTAL RESULTS

The results obtained from germinating two lots of pea seed, treated and untreated, in autoclaved and unautoclaved compost at 20°, 15°, and 10°C are presented in Tables 1, 2, and 3, respectively.

The germinations listed for Lot No. 1 in Table 1 and for Lot No. 2, unautoclaved compost, Table 3, are the mean germinations of duplicate tests. The duplicate tests of Lot No. 1 autoclaved soil, with the exception of the $HgCl_2$ treatment, were within the range of tolerance. However, in the case of the unautoclaved compost, Lot No. 1, Tables 1 and 3, five of the duplicate tests were outside the range of tolerance.

The data presented in Tables 1, 2, and 3 show that probably the most important thing to be learned from the experiment is the effect exerted by the substratum on the germination of a given lot of seed. For example, the germination of Lot No. 1, (control) at 20°C was 88% strong, while a similar set from the same lot of seed gave a germination of 21.5% in unautoclaved compost. Seed from Lot No. 2 gave a germination of 98% in autoclaved, and 70% in the unautoclaved compost. The results at 15° and 10°C were similar to those obtained at 20°C except that Lot No. 2 was progressively reduced in germination from 20° to 10°C.

It may be noted that the difference between the germinations of similar sets of seed in autoclaved and in unautoclaved compost is significant in nearly every case at all temperatures. The exceptions are as follows: In Table 1, for Lot No. 2, the difference in germination between the cuprocide treatment in autoclaved and unautoclaved soil is not significant. The same is true for the Formafume treatment. In Table 2, for Lot No. 1, the difference between the copper oxychloride, the Ceresan, and the 1% ethyl mercury phosphate treatments in autoclaved and unautoclaved compost is not significant. Likewise this is true for the Cuprocide treatment for Lot No. 2, Table 2. In Table 3 all individual comparisons in autoclaved and unautoclaved

compost are significantly different with the exception of the Ceresan treatment of Lot No. 2.

TABLE 1.—*Germination of two lots of pea seeds, treated and untreated, in autoclaved and unautoclaved compost at 20°C.*

Treatment	Germination			
	Autoclaved compost		Unautoclaved compost	
	Lot No. 1	Lot No. 2	Lot No. 1	Lot No. 2
	%	%	%	%
$HgCl_2$, 1–500	74[1]	99	36	79
Cuprocide	82	98	62	89
Copper oxychloride	78	95	47[1]	70
Formafume	88	97	24[1]	85
Ceresan	92	96	54[1]	79
1% Ethyl mercury phosphate	87	98	64	82
Check control	88	98	22[1]	70

[1]Duplicates outside the range of tolerance.

TABLE 2.—*Germination of two lots of pea seeds, treated and untreated, in autoclaved and unautoclaved compost at 15°C.*

Treatment	Germination			
	Autoclaved compost		Unautoclaved compost	
	Lot No. 1	Lot No. 2	Lot No. 1	Lot No. 2
	%	%	%	%
$HgCl_2$, 1–500	59	94	42	35
Cuprocide	58	57	65	62
Copper oxychloride	63	87	48	29
Formafume	80	71	44	30
Ceresan	62	—[1]	73	66
1% Ethyl mercury phosphate	72	—[1]	70	54
Check control	59	93	32	28

[1]Mercury injury, no reading taken.

TABLE 3.—*Germination of two lots of pea seeds, treated and untreated, in autoclaved and unautoclaved compost at 10°C.*

Treatment	Germination			
	Autoclaved compost		Unautoclaved compost	
	Lot No. 1	Lot No. 2	Lot No. 1	Lot No. 2
	%	%	%	%
$HgCl_2$, 1–500	63	95	26	51
Cuprocide	73	97	32	65
Copper oxychloride	64	95	26	43
Formafume	73	98	22	38
Ceresan	93	89[1]	53	87[1]
1% Ethyl mercury phosphate	78	99	43	85
Check control	70	91	21	22

[1]Slight mercury injury evident.

The effect of seed treatment as a means of increasing germination in unautoclaved soil is apparent at all temperatures. An increase in percentage germination over the checks was obtained with all treatments and at all three temperatures when unautoclaved compost was used as a medium for germination. However, in a few cases the increase in percentage germination with some treatments was small and insignificant. Cuprocide, Ceresan, and 1% ethyl mercury phosphate on Lot No. 1 gave significant increases in germination over that in the checks at all three temperatures. The same treatments on Lot No. 2 gave significant increases in germination over the untreated checks at 10° and 15°C while Cuprocide gave the only significant increase at 20° C. The results obtained with the other seed disinfectants used were somewhat inconsistent, although significant increases in germination resulted from their use in some cases. Unquestionably, soil-borne organisms were partially controlled by seed treatment under the artificial conditions which prevailed in the laboratory, but it should not be assumed that similar increases may be expected in the field.

On the other hand, when autoclaved compost was employed as the medium for germination, seed treatment appeared less beneficial. With Lot No. 1, a significant increase in germination due to seed treatment was obtained in only two cases, the Formafume treatment at 15°C and the Ceresan at 10°C. In the case of Lot No. 2, significant increases over the control were obtained by three seed treatments.

The desirability of the grower obtaining high quality seed is also emphasized by the foregoing data. The disease-free lot of Alaska pea seed obtained from Idaho consistently gave the highest percentage germination in both autoclaved and unautoclaved compost, whether treated or untreated.

In addition to the above experiments, the desirability of autoclaved sand and autoclaved compost as a medium for germination was investigated from the standpoint of both total percentage germination, and time required to complete the germination test. A sample of Alaska peas of unknown origin was passed through the divider to insure uniform sampling. Two hundred seeds were planted in autoclaved sand and 200 in autoclaved compost, which was from a different source than that used in the previous experiments. Germination tests were made in the copper pans mentioned above, one 50-seed sample in each end of the pan, or 100 seeds per pan, and

TABLE 4.—*Comparison of autoclaved sand and autoclaved compost at 20°C as a medium for germinating pea seeds.*

Days of test	Germination[1]							
	Autoclaved sand				Autoclaved compost			
	A	B	C	D	A	B	C	D
	%	%	%	%	%	%	%	%
7	96	94	100	96	40	60	88	74
9	—	—	—	—	24	8	4	12
12	—	—	—	—	10	4	2	—
Total germination	96	94	100	96	74	72	94	86
Average germination, %	96.5				81.5			

[1]50 seeds in each replication.

at 20°C. The samples were observed each day and the seedlings were removed as rapidly as they attained a height of approximately 1½ inches. The results obtained are presented in Table 4.

It may be noted that a very uniform and rapid germination of pea seed was obtained in the autoclaved sand. The pans were all held 14 days but no germination occurred after the seventh day. On the other hand, germination in autoclaved compost was not as uniform, 14 days being required to get the final count on emergence. The average germination in autoclaved sand was 96.5% while that in the autoclaved compost was 81.5%.

The above results are somewhat contradictory to those given in Table 1 for Lot No. 2. They suggest, however, that some samples of autoclaved soil may be injurious to the germination of pea seeds. More tests are needed before definite conclusions may be drawn.

DISCUSSION AND SUMMARY

Tests to determine the influence of seed-borne or soil-borne organisms and the effect of the medium employed for germination were made on two lots of Alaska pea seeds. Lot No. 1 contained a high percentage of badly diseased seed, while Lot No. 2, which was obtained from Idaho, was a high quality sample.

The medium used for germination had a marked effect on the germination of both lots of seed, the autoclaved compost giving a consistently higher percentage of germination of both treated and untreated seed.

Seed treatment was decidedly beneficial in obtaining maximum germination of the two lots of seed, particularly in the unautoclaved compost and at the lower temperatures. One per cent ethyl mercury phosphate, Ceresan, and Cuprocide were the most beneficial treatments used.

The results obtained indicate that it is highly desirable for the grower to obtain high quality seed for field planting.

Germination tests of one lot of seed at 20°C comparing autoclaved sand and autoclaved compost as a medium for pea seed germination, suggest that the autoclaved sand is superior to the compost in regard to both total percentage germination and time required to complete the test. The data suggest that autoclaved soils vary in their value for pea seed germination.

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INFLUENCE OF CHEMICAL AND SOIL FACTORS UPON THE GERMINATION OF SEEDS OF SMALL GRAINS[1]

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Although the concepts of increasing the soil emergence of cereal seedlings through the application of chemicals is neither new nor radical, there is little available information on the subject. The exhaustive efforts of Porter and Layton (6),[2] Koehler (4), Christensen and Stakman (1), and Leukel (5) have demonstrated clearly that under field conditions certain seed disinfectants increase the soil emergence while others exert a depressing effect on the seeds. Several limitations of work under field conditions are at once evident to those interested primarily in seed testing. The equipment in most laboratories maintains environmental factors on a more uniform level than is possible in the field, and therefore, less variation should be expected in the laboratory. Many of the interesting and valuable aberrations in seedling development cannot be followed in the field, whereas greenhouse flats and beds, and especially laboratory towels, permit critical examinations of the seeds and seedlings. Because of the disease factor involved, only a few chemicals are commonly used for testing of cereals, and hence the data on soil emergence is limited to these.

The recent technique of treating vegetable seeds as developed by Horsfall (2, 3) was erected on the efficiency of two chemicals, cuprous oxide and zinc oxide. These and other materials used in vegetable seed work, a mercury compound (Merko) recommended for corn and the dusts of commercial importance in cereal disease control, were compared in a number of experiments. As shown in Table 1, the treated wheat was planted in sand, clean soil, and highly contaminated soil one month after the treatments were made. The seed had been stored in tight sacks which prevented rapid dispersion of gases. Apparently no significant chemical injury had developed during this storage period. The results from the contaminated bed, however, indicated that Smuttox depressed the soil emergence under these conditions. The formaldehyde dusts, Ansul, and Smuttox undoubtedly effected no protection against soil organisms. All of the copper compounds were protective, as were the mercury and zinc compounds. Leukel (5), working with very similar compounds, found that the soil emergence was increased, in rich, unsterilized soil with some varieties of oats but not with others.

The germination percentages for stored seed (Table 1) are illustrative of the injury taking place during prolonged storage. The differences between soil conditions and paper-towel conditions are so great that misleading germination reports may be issued on the basis of the laboratory tests. Many slightly injured sprouts in the Ceresan and New Improved Ceresan samples will develop normally in soil and recognition should be given to this fact. On the other hand, only the strong normal sprouts in the formal-

[1]Approved by the Director of the New York State Agricultural Experiment Station for publication as Journal Paper No. 221.

[2]Numbers in parenthesis refer to Literature Cited.

TABLE 1.—*Comparison of soil emergence in greenhouse and of green weights of tops for wheat which was treated with various chemicals—Treated April 15, 1936.*

Chemical used as dust	Seedlings, weights of tops[1]						Seedlings and green weights of tops[2]			
	Clean sand		Clean soil flats		Contaminated beds		Paper towels, sprouts		Once-used soil beds	
	Seedl.	Tops	Seedl.	Tops	Seedl.	Tops	Normal[3]	Injured	Seedl.	Tops
	%	Gms.	%	Gms.	%	Gms.	%	%	%	Gms.
Ansul	87	11.5	93	86.8	63	76.0	73	0	48	87.8
Ceresan	88	12.6	96	98.7	79	70.2	75	20	80	168.0
Copper carbonate	94	11.7	89	93.0	69	75.1	91	0	84	163.4
Copper sulfate	85	8.5	96	95.2	83	83.0	74	11	85	160.3
Cuprous oxide	95	9.9	84	92.2	75	76.3	84	0	77	157.1
Merko	93	11.5	95	92.8	72	63.5	95	0	79	129.9
N. I. ceresan	99	10.9	93	105.8	82	79.8	80	15	85	167.0
Sanoseed	91	9.8	96	91.0	64	54.7	94	0	75	141.8
Smutbane	89	10.8	94	93.3	72	65.7	96	0	78	146.9
Smuttox	91	10.4	90	90.3	46	61.4	49	0	34	57.2
Zinc	87	10.6	93	101.1	69	67.6	91	0	78	159.1
Control	88	10.5	95	102.8	62	55.3	89	0	68	124.8

[1]Planted May 14, 1936.
[2]Tested April 22, 1937.
[3]Weak sprouts were not added to these percentages. The germination test results for formaldehyde dusts, Ansul, and Smuttox contained considerable numbers of small, distorted seedlings.

TABLE 2.—*Influence of ethyl mercuric phosphate on soil emergence in greenhouse and on green weight of tops of oats. Samples taken from survey of farmers' grains.*[1]

Survey No.	Seedlings grown in				Green weight of tops			
	Pots		Beds		Pots		Beds	
	Check	N. I. C.	Check	N. I. C.	Check	N. I. C.	Check	N. I. C
	%	%	%	%	Gms.	Gms.	Gms.	Gms.
48	92	84	84	96	34.0	28.0	42.7	43.7
49	96	88	96	98	28.0	29.6	33.1	37.3
50	100	92	100	100	22.4	26.0	40.0	43.2
51	94	94	100	98	23.0	29.8	24.2	26.8
52	88	68	82	100	21.8	22.5	22.6	28.3
53	78	82	76	88	19.7	19.1	21.9	21.8
54	94	84	92	76	22.0	26.0	20.0	21.2
55	76	82	78	96	17.7	22.2	15.5	26.0
56	96	84	82	88	21.6	20.0	18.3	21.2
58	92	92	98	100	28.3	24.8	27.1	33.1
Average	90.6	85.0	88.8	94.0	23.9	24.8	26.5	30.2

[1]Seeds were dusted with ethyl mercuric phosphate (New Improved Ceresan) at rate of one-half ounce per bushel.

TABLE 3.—*Comparison of influence of ethyl mercuric phosphate and formaldehyde dust on soil emergence in greenhouse and on green weight of tops of barley when planted in pasteurized and untreated soil.*

Lab. No.	Soil emergence			Green weight of tops		
	Check	N. I. C.[1]	Smuttox[2]	Check	N. I. C.[1]	Smuttox[2]
	%	%	%	Gms.	Gms.	Gms.
Pasteurized Soil:						
2498	86	89	96	70.0	73.5	84.6
5108	94	89	86	87.2	98.2	93.5
7876	85	81	89	61.2	62.5	60.0
8762	78	86	80	52.5	76.6	65.0
8763	81	93	84	63.9	78.0	91.0
9928	63	66	55	51.3	77.7	58.6
9978	98	87	83	74.0	69.5	84.9
9979	56	82	57	32.8	58.1	38.1
9982	88	98	91	68.3	71.6	70.3
10271	76	94	83	52.8	69.9	66.4
10275	71	78	65	56.9	54.8	46.5
10297	99	98	91	70.2	65.3	72.9
10781	87	84	82	74.7	99.0	81.1
10895	90	89	96	81.2	64.3	61.5
19978	93	91	91	62.5	90.1	85.9
Average	83	87	82	64.0	77.9	70.7
Slightly Contaminated Soil:						
2498	88	84	86	56.2	59.5	58.4
5108	92	100	85	57.5	75.9	77.7
7876	64	74	76	40.0	50.2	62.4
8762	70	77	90	39.9	48.3	48.0
8763	80	94	100	55.5	57.7	59.6
9928	68	67	60	35.5	53.5	48.4
9978	96	89	95	48.8	64.0	69.5
9979	49	83	56	21.3	55.4	34.3
9982	87	97	85	45.3	65.0	59.6
10271	90	84	79	44.7	50.3	47.2
10275	57	72	69	33.5	42.0	40.4
10297	80	91	91	45.0	62.3	66.3
10781	86	90	89	53.3	61.4	64.0
10895	89	87	89	51.7	51.5	52.8
19978	80	83	95	52.7	69.4	71.8
Average	78	85	83	49.4	57.7	57.4

[1]New Improved Ceresan is 5% ethyl mercuric phosphate in talc.
[2]Smuttox is 4% formaldehyde in an inert dust.

dehyde dust samples should be counted as germinated. If any conclusion should be drawn from these results, it is that under a variety of soil conditions the seeds treated with ethyl mercuric phosphate (N. I. Ceresan) and ethyl mercuric chloride (Ceresan) are very well protected and the seedlings are generally more vigorous than those from copper-treated, formaldehyde-dust-treated or untreated seeds.

In a few experiments, ethyl mercuric phosphate did not uniformly increase the number of seedlings. Oat samples taken directly from collected farmers' granaries in a recent survey were grown in the greenhouse to determine their ability to produce seedlings. A few samples were treated in part and the soil emergence and green weight of treated and untreated

portions were compared. The results are given in Table 2. It is peculiar, but nevertheless true, that treatment depressed the germination of oats planted in five-inch pots but increased the stand in deep beds. The weights of the tops indicate that growth was accelerated by the treatment. The influence of ethyl mercuric phosphate and formaldehyde dust upon germination and growth was determined for a number of barley samples. The samples were treated, counted out in lots of 100, and planted in duplicate in pasteurized and slightly contaminated soil. Formaldehyde dust, as is evident in Table 3, appeared to depress germination in some lots but increased the soil emergence significantly for others. Ethyl mercuric phosphate produced similar results. Under conditions in highly contaminated soil, the results probably would have shown considerable increase in the ethyl mercuric phosphate treated lots over either the untreated or formaldehyde dust treated samples.

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OPENING DISCUSSION OF ROUND TABLE ON SEED GERMINATION PROBLEMS

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In opening this program on germination problems, it is not planned to give detailed information but briefly to review the types of problems that confront all of us. It is hoped to stimulate discussion that will bring out much new information that will be helpful.

The seed is a resting stage in the life of the plant. The seed as we receive it may not have developed properly. It may have been injured in some way or special adaptations of the particular seed kind may require unusual treatment before active growth is resumed. In our task of determining the possible plant producing value of a sample of seed, we are confronted with many problems, most of which naturally fall into two general groups; (I) getting all viable seeds to germinate, and (II) interpreting the result of the germination test.

I. GETTING ALL VIABLE SEEDS TO GERMINATE

Many crop seeds usually resume activity under a wide range of germination conditions, but most kinds of seeds sometimes, and some kinds always require very special conditions for growth.

Dormancy, a term that is used rather loosely by most of us to describe a wide variety of special requirements for germination, has been discussed a great deal before this Association and will not be considered in detail here.

Probably the most frequent dormancy problem is that often occurring in freshly harvested seeds of common crops. The requirement of low temperatures for the early stage of germination of freshly harvested cereals, of light for freshly harvested timothy, and of high temperatures for freshly harvested melons are examples that have previously been brought to your attention. This problem is especially troublesome because the degree of dormancy and length of the dormant period may vary in different seasons and we seldom know the previous history of our samples.

Other problems concern special requirements for certain varieties, as with lettuce, and different requirements depending upon the previous history of the sample as with some species of Fescue.

Region of production may affect the germination requirement of seeds. We have found that imported Dallis grass seed is more often benefited by light and potassium nitrate than is domestic seed. Also, North European timothy requires a longer duration of test than American seed.

In the last few years many new crop plants are being introduced and this presents new problems. Comparative tests must be made to find the most suitable method of testing to obtain complete germination. Some of these new crops are native plants which have very special germination requirements. Several species of *Panicum* that are being used in soil conservation work have given us a great deal of trouble.

Many tree, ornamental, weed, and other seeds may require a long period of pretreatment before they will respond to ordinary conditions of germination. We still require much more information for successful germination tests of many such kinds of seeds.

The analyst must be continually on the watch for unusual samples where all the viable seeds do not respond to the germination conditions he has furnished. Methods of testing must be based upon long experience with varied types of samples and should not be based on a few trials on a small number of samples that may not be representative.

The problem of hard seeds in legumes is mainly one of reporting and of judging the field value of the hard seeds, but there is also the problem of possible changes in the hard seed content of a small sample held in the laboratory where it is subject to drying before being tested. Vetch seed is a conspicuous example of this.

II. INTERPRETATION OF THE GERMINATION TEST

Even if we feel sure that we have provided conditions that will cause all viable seeds to germinate, all of our problems are not by any means solved. I believe that we are all agreed that in determining seed value, the ultimate purpose is to serve agriculture and that for this purpose we must determine the ability of the seed to develop into a useful plant. A seed may start growth, but for various reasons inherent in the seed, it may not be capable of continued development. In this connection the analysts must keep in mind that he should estimate the potential value of the seed and not the effect of environment in the field. Our attitude toward interpretation of the germination test should be that we all, commercial or official analysts, are trying to determine the value of seeds for planting purposes.

It has been suggested that really good samples do not present these problems of interpretation, which is true, but if all the samples were good there would be no special need of testing. The real responsibility of the analyst is to detect and report the relative value of seeds of questionable quality.

I believe that we will understand our problems of interpretation more clearly if we consider briefly the causes of the abnormal seedlings that are not capable of continued development. In extensive studies of factors affecting longevity, our laboratory has found that the first evidence of failing vitality is slower germination. There is no evidence that such seeds are not capable of making useful plants. The next stage is either poor root development or lack of growth of the plumule. These actively growing regions are the first to lose the power of continued development. Watery seedlings, due to a breakdown of cellular membranes, may also be expected at this time. It is at this stage that most of our troubles are found, because there is no sharp dividing line between ability to produce a plant, although not of full vigor, and lack of ability to continue functioning. Later, the seed may still have ability to evidence growth in some one tissue as in the sheath of grasses or the hypocotyl of legumes, but the inability to produce a plant should be evident to all. The transition from this stage to complete death of the seed usually is rapid. When storage conditions are only slightly unfavorable and the rate of loss of vitality is slow, these various stages of abnormality are numerous, but under very unfavorable conditions the transition from full vigor to death is so rapid that abnormal seedlings are not a major problem.

In many cases, mechanical injury during harvesting or merchandising causes injury to some essential part of the seed without preventing growth of the separate parts. This results in the familiar "broken seedlings", which in themselves should present no serious problem if the test is not counted before the degree of injury becomes evident. A troublesome problem does exist, however, when slight injury, not in itself fatal to development, accelerates aging of the seed and causes weakened vitality of the somewhat injured seedling.

Weakened vitality, from whatever cause, is usually accompanied by fungus development. Whether the fungus activity is a cause or a result of the weakened vitality, probably varies in different cases, but the spread of saprophytic fungi from dead or weakened seedlings may injure seedlings otherwise capable of making useful plants.

Soil tests have been discussed for some years as a means of interpreting the value of seedlings. The soil test aids in preventing the spread of fungi, and for that reason often prevents unjust judgment of samples that contain some injured seeds. The soil test helps to discriminate between useful and useless seedlings when the line of demarkation in an artificial substratum is not sharp. The longer and more normal development possible when seeds are tested in soil makes detection easy of many abnormalities that are not readily evident in a blotter test. Also, the soil test is often a desirable substratum for inducing germination where it is difficult to get all viable seeds to germinate.

Our own laboratory staff feels, after extensive trials, that sand tests do not offer the same aid in interpretation that is furnished by soil tests. It must be recognized that any test, soil, sand, or other medium, made in the

germination chamber has only limited value in comparison with greenhouse tests.

We will briefly review a few of the more conspicuous problems in interpretation, hoping that further discussion on these points will bring out valuable information.

Due to mechanical injury, beans often have the plumule injured without other apparent defects. The extent of such injury is much more easily detected in a greenhouse test than in the laboratory.

The seeds of grain sorghums are easily injured and such injury is often accompanied by fungus growth. We have found many samples very difficult to interpret. A similar condition may often occur in cereals. In both cases soil tests are very helpful.

In grasses, we often find poor root development of redtop and timothy and lack of growth of the plumule in fescues and other grasses.

The interpretation of tests of clovers has been considered in our Association more than any other class of seed. We will mention here only the observation that many samples of sweet clover show very poor root development in blotters although root growth in soil may be normal.

EQUIPMENT

The question of equipment for the laboratory touches both of the above groups of problems. Seeds in nature or in the field are subjected to a series of conditions, some of which are suitable for germination, but when we wish to test the seeds under artificial conditions and within a definite time we must provide conditions controlled to suit the particular requirements of the particular kind of seed to be tested.

Moisture, aeration, temperature, and light are the conditions we usually attempt to control. Moisture and aeration are in part determined by the substratum upon or in which the seeds are tested. This substratum should be suitable for the needs of the seed being tested. Mr. Goss has called attention to an unusual sample of endive seed that germinates very little between or on top of blotters, but grows rapidly on moist cotton in petri dishes or on paper in petri dishes if the test is flooded with water. On the other hand, spinach and New Zealand spinach will germinate very poorly if the substratum supplies enough water to completely saturate the spongy fruit covering. It should be noted here that the requirements in such cases are not for a specific substratum but for the correct management of a suitable substratum.

For the control of temperature, and the maintenance of suitable moisture, a germination chamber is essential. Many types of chambers have been devised to meet different conditions. Here again, uniformity of germination results will be attained, not by the use of any specific type of germination chamber, but by the proper management of equipment suitable to provide the required conditions. In providing light during germination it must be remembered that temperature also must be controlled in a suitable way. The ideas of this laboratory on germination equipment suitable for our own needs may be gathered from a visit to our laboratory.

There are numerous possible mechanical aids in the germination laboratory such as vacuum counters, counting boards, soil test containers, and others. The experiences of individual laboratories may be of great help to other laboratories.

In conclusion, I wish to repeat that I have not attempted to present new ideas on germination, but I hope that this review of germination problems will stimulate you to present experiences that will help us all in making our results more dependable and more informing.

GERMINATION OF CUCURBIT SEED IN SAND[1]

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For several years the seed laboratory at Iowa State College has been requested to make germination tests of improved varieties of cucurbit seeds for certification either by the Iowa Melon Growers' Association or by the State Department of Agriculture. Germination by the official method between blotters at 20–30°C has resulted in either a lower germination than in sterile sand in the greenhouse at a higher temperature or the time required for complete germination was longer.

As a result of the above experiences, a series of tests were made in the winter of 1936, soon after the harvested seeds were cleaned and ready for distribution, with material from the experimental plots of the Botany and Plant Pathology Section of the Iowa Experiment Station at Conesville, Iowa. The methods used were (1) germination between blotters at 20–30°C and (2) germination at 20–30°C and at 35°C in sterile sand in copper boxes 6 x 12 x 1½ inches. Two, or 4 x 100 seeds were used in all tests. Seed lots used included two lots of watermelon seed (No. 1 Improved Stone Mountain and No. 2 Improved Kleckly Sweet), one of cucumber (No. 3 Shamrock), and two of cantaloups (No. 4 Cantadew and No. 5 Superba). The sand trays and blotters were examined each day and as the seed germinated they were removed. The number of seeds germinating and the number of days required to complete the germination test were recorded.

The data obtained by germinating five lots of cucurbit seed between blotters at 20–30°C and in autoclaved sand at 20–30°C are presented in Tables 1, 2, and 3.

Examination of Table 1 shows that important differences between the recommended method and the sand tray method were obtained in the germination of watermelon seed. It may be noted in the case of Lot No. 1 (Improved Stone Mountain) that the total percentage germination in sand at either 20–30°C or 35°C was just as high as that obtained by the recommended method, but four days less time was required to complete the germination test. At 35°C maximum germination was practically completed in four days in sand. In Lot No. 2 (Improved Kleckly Sweet), a very mediocre lot of seed, the difference was even more apparent. The germinations were completed in six and seven days less time, showing an increase in germination of 14.5% and 18.0% in the test completed Jan. 4, and an increase of 21.7% and 23.5% in the test completed May 31, with the greatest advantage obtained at the higher (35°C) temperature. The reduced germination of Lot No. 2 in blotters can hardly be attributed to the later period because

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TABLE 1.—*Comparison of germination of watermelon seed in blotters and in sand*

Date	Temp. C.	Germination by days						
		3	4	5	7	9	11	14
		%	%	%	%	%	%	%
Lot No. 1—Sand								
Jan. 4	20–30°	—	77	78	82	—	—	—
	35°	70	84	86	87	—	—	—
May 31[1]	20–30°	—	—	60	83	—	—	—
	35°	78	82	83	83	—	—	—
Lot No. 1—Blotters								
July 8	20–30°	—	—	—	81	82	82	—
Lot No. 2—Sand								
Jan. 4	20–30°	—	—	—	57	60	—	—
	35°	—	32	—	64	—	—	—
May 31[1]	20–30°	—	—	33	66	67	—	—
	35°	41	56	65	67	69	—	—
Lot No. 2—Blotters								
July 8	20–30°	—	—	—	31	43	45	46

[1]Four hundred seeds in test; all others, 200 seeds.

TABLE 2.—*Comparison of germination of cucumber seed in sand and blotters. Lot No. 3, Shamrock.*

Date	Temp.	Germination by days						
		3	4	5	6	7	8	10
	C	%	%	%	%	%	%	%
Sand								
Jan. 4	20–30°	90	94	94	—	96	—	—
	35°	52	75	87	—	90	—	—
June 9[1]	20–30°	65	—	97	98	—	98	—
	35°	9	—	47	63	88	—	—
Blotters								
July 8	20–30°	—	91	—	—	94	—	96

[1]Four hundred seeds in test; all others 200 seeds.

only five weeks elapsed betwen the last sand test and the blotter test and no decrease in Lot No. 1 was noted.

Lot No. 3 (Shamrock cucumber) (Table 2) showed differences in germination time similar to those obtained in Lot Nos. 1 and 2, although somewhat smaller, amounting to two days at both 20–30°C and 35°C in the test Jan. 4, while the time required for the June 9th test was one and two days less than that required for the blotter test. However, a lower germination was obtained in the sand trays at the higher temperature.

With Lots Nos. 4 and 5 (Table 3, Cantadew and Superba cantaloups) an advantage in time required to complete the germination test was obtained by use of the sand trays on Jan. 4, as compared with the blotter test July 8. A pronounced advantage of the high temperature was noted for Lot No. 4

when the first test was made. The test on June 9 indicated an advantage as to time and total germination of Lot No. 4 for the alternating temperature in sand.

TABLE 3.—*Comparison of germination of cantaloup seed in sand and blotters.*

Date	Temp.	Germination by days						
		3	4	5	6	7	8	9
	C	%	%	%	%	%	%	%
Lot No. 1—Sand								
Jan. 4	20–30	—	89	—	—	—	—	—
	35	93	95	98	—	—	—	—
May 31[1]	20–30	1	—	94	97	—	—	—
	35	69	—	89	91	—	—	—
Lot No. 1—Blotters								
July 8	20–30	—	93	—	—	96	—	96
Lot No. 2—Sand								
Jan. 4	20–30	—	95	—	—	96	—	—
	35	98	99	100	—	—	—	—
May 31[1]	20–30	—	—	97	98	—	98	—
	35	84	—	94	95	—	97	—
Lot No. 2—Blotters								
July 8	20–30	—	95	—	—	97	—	—

[1]Four hundred seeds in test; all others 200 seeds.

SUMMARY

Tests to determine the total germination percentage and comparative time required to complete the germination tests of five lots of cucurbit seed showed no significant differences in total percentage germination in sand between the 20–30°C and 35°C temperatures except for cucumber at 35°C and Lot No. 4, Cantadew, when tested in January. Germination of cucumber seed was reduced and of cantaloup seed increased at 35°C. No significant differences in total germination percentage were found between the blotter and sand tray methods, with the exception of Lot No. 2, watermelon, where a significantly higher germination was obtained in the sand. However, with the number of days required to complete a germination test being an important factor in maintaining germination space and expediting service work, an advantage in favor of the sand tray method was obtained with two to seven days less time required to complete a germination test than was required by the recommended blotter method. An additional value is that normal seedlings can be more readily detected in sand than in blotters.

FLUORESCENCE READINGS OF THE STRAINS OF THE SPECIES OF *LOLIUM*[1]

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The separation of the species and strains of the ryegrasses (*Lolium*) into non-fluorescent (long-lived) and fluorescent (short-lived) forms by their capacity to show fluoresence under ultraviolet radiation, as has been shown by various investigators, has proved entirely practical and in many cases extremely useful.

During the past few months, there have come into use for soil conservation planting purposes in New York State, a number of commercial stocks of new strains of types of *Lolium*. In Table 1 a list of strains of ryegrasses, including their trade names, together with an indication of their approximate fluoresence reading or index under screened ultraviolet light as we have observed them, is presented. This list is given at this time not with the thought that it is complete or entirely correct, but with the intention that it may prove useful to those interested in this type of work and will encourage further observations.

TABLE 1.—*Strains of rye grasses together with their respective fluorescence readings.*

Kind or Strain	Fluorescence Reading
1. Domestic Ryegrass *Lolium* spp.	Varies from 50% to completely fluorescent for some lots.
2. Italian Ryegrass *Lolium multiflorum*	Normally highly fluorescent, often complete.
3. Westerwoldts Ryegrass *Lolium Westerwoldicum*	Highly fluorescent, often complete.
4. Perennial Ryegrass *Lolium perenne* English grown commercial Paceys (so-called) short-seeded Cornish Eaver Indigenous Evergreen Irish grown commercial Scotch grown (Ayrshire) New Zealand grown-"Certified"	Normally non-fluorescent. Some lots completely non-fluorescent, others show a trace, to as high as 5% of fluorescent individuals which may be awnless seeds from Italian ryegrass.
5. New Zealand grown "Commercial perennial" short-lived strains South Island stocks	From 10% to complete fluorescence. Average about 50% fluorescent individuals.
6. Danish grown commercial stocks	
(1) E. F. 79 strain (Late)	Trace
(2) Lundbaek (Early)	13 to 18% fluorescent
(3) Otofte (Early)	5 to 7% fluorescent
7. New York grown	Non-fluorescent
8. Norwegian grown, Jädersk	Trace
9. Swedish grown commercial stocks	
(1) Viktoria (mid-season)	Trace
(2) Weibold strain	Trace to 5 to10 % fluorescent
(3) Svalof strain (Late)	Trace

[1]Journal Paper No. 229 of the New York State Agricultural Experiment Station.

The fluorescence reading of the test must be interpreted with care and the final results must be weighed along with all other available supporting evidence or facts known concerning the origin or breeding of the particular stock in question. In all cases where the seed stocks were "certified" or were received under seals, the fluorescence readings were found to be excellent supporting evidence. Fluorescence readings made upon suspicious appearing stocks or those from unknown or uncertain sources have proved to be exceedingly useful as evidence upon which to make further inquiry.

In setting up the tests it does not appear to be so important as to what kind or quality of paper is used for the immediate substratum so long as it is a white, soft filter paper capable of holding plenty of moisture, since on a moist paper the roots adhere closely to the paper and thus show a pronounced or brilliant blue fluorescence. It was once thought that the best readings were secured when the germination tests were made in darkness, but it has since been found that good results can be secured when the germinating seedlings are produced in a daylight chamber.

To obtain the percentage of fluorescent individuals in any lot of seeds, a fairly accurate estimate can be obtained by placing the seeds rather far apart on the substratum. We have found that an excellent method to get an accurate percentage is to place one seed in the center of each of 50 or 100 glass bacteriological rings placed side by side on the top of the moistened, smooth filter paper which rests on a firm surface. These inexpensive glass rings which are normally used for bacteriological hanging drop mounts serve to keep the growing rootlets within the confines of the rings where they can be easily counted.

Recent development of exceedingly efficient and inexpensive generators of ultraviolet radiation, both portable and stationary, make it easy to purchase or to construct a very satisfactory outfit for all practical purposes. This is outlined in the "Rules for Seed Testing". We have found the small portable "black light" unit sold for a few dollars to be a very satisfactory source of ultraviolet radiation. This portable unit consists of an ultraviolet lamp (an argon mixed-gas glow lamp) mounted in a socket in an ordinary extension cord with plug, and enclosed in a molded "black light" filter. With this outfit in hand, an entire tray of germinating seedlings, placed on a table in a darkened room, or in a dark room, or even in a darkened box, can be viewed and studied with complete satisfaction.

HARD SEEDS IN LEGUMES: CORRELATION BETWEEN LABORATORY AND FIELD GERMINATION[1]

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The interest in the behavior of hard seeds of legumes in the laboratory and in the field is a continuing one. As early as 1894, Michalowski (12),[2] in Germany, had perfected a machine to scratch the hard seeds and cause them to germinate, and three years later, Rostrup (15), in Denmark, had treated the seeds with sulphuric acid for the same purpose. By 1912 to 1915, hard seeds were receiving attention in America. Love and Leighty (8), in New York, were experimenting with acid treatment and Hughes (6), in Iowa, had invented a scratching machine which he calls a scarifier. This scarifier was soon followed by many other similar machines, some of which are in use at the present time.

The structure of the seed coat of legumes was studied by Pammel (14) as early as 1899, and some 20 years later by Coe and Martin (1), and independently by Lute (10). These later studies were for the purpose of learning why some seeds are hard while others are not. Studies on the behavior of hard seeds in the laboratory were begun in the United States by Harrington (4) and Goss (3) in 1915 and 1916, and were soon followed by other investigators, both in this country and in Europe.

The interpretation of the value of hard seeds was undertaken by Harrington (5) in 1916 and by Lunz (9) in 1921. Also in 1921, French (2) made a survey of how the various seed laboratories were reporting hard seeds, and presented a very comprehensive report. The same year, the Association of Official Seed Analysts of North America went on record (13) as approving the labeling of seeds by adding the hard seeds to the actual germination and also stating the hard seeds separately on commercial labels. That this action met with much favor with the seed trade was shown by the report which Massie (11) made to the American Seed Trade Association.

Field trials on hard seeds were begun in Montana by Whitlock (17) in 1914 and were later continued on an extensive scale by Whitcomb (17) in 1921. In 1923, Lute (10), of Colorado, reported results of field tests on hard seed separations, and in the following year, Schmidt (16) began his studies in Wisconsin, on a fellowship for the American Seed Trade Association. Leggatt (7) began his studies of hard seeds under field conditions in Alberta, Canada, in 1926.

Thus it will be seen that the various phases of the subject of hard seeds have received attention for the past 43 years or more. These phases have had to do with the treatment of the seed to cause it to grow, the structure of the seed coat and the reason for some seeds being hard, behavior of seeds in the laboratory, interpretation of the value of such seeds, and field trials. It is of interest to note that the treatment of these abnormal seeds to cause them

[1]Contribution from Montana State College, Agricultural Experiment Station. Paper No. 102, Journal Series.

[2]Numbers in parenthesis refer to Literature Cited.

to grow was the first phase of the work undertaken. All of these studies have had a direct bearing on the crop producing properties of these seeds and the place which the laboratory test has in the interpretation of such properties.

At the present time, the seed dealers are inclined to place a somewhat higher value on the hard seeds than has been customary for the analysts and the seed control officials. There seems to be a need for a better understanding of the behavior of these hard seeds in the laboratory and in the field. It was for the purpose of contributing something which might be helpful in solving this problem that the work, on which a report is made in this paper, was planned.

EXPERIMENTAL WORK

This work has to do with the relationship between the germination of seeds containing hard seeds when tested in the laboratory and in the field. The work has been done with rather large numbers and the results obtained have been analyzed in part by the statistical method. This method permits of the stating of relationships between laboratory and field tests in terms of correlation coefficients and detecting relationships which are not otherwise apparent.

MATERIALS AND METHODS

The seeds were selected from laboratory samples which had been received for test. They consisted of alfalfa, sweet clover, red clover, alsike clover, and white clover. The alfalfa seeds were selected entirely from the Montana laboratory, while the other seeds were furnished by the laboratories of North Dakota, Minnesota, Wisconsin, Iowa, and Montana. These seeds are listed in Table 1, together with the mean values for the laboratory and field tests of each. The lots of seeds from the various laboratories were kept separate and the results treated as units when the number of samples were sufficient, but in other cases it was necessary to combine the results for analysis. Two lots of alfalfa were selected. One was designated as "Low hard seed content" and had an average germination of 78% with 10% hard seed, while the other one, which is listed as "High hard seed content" had a germination of 46% with 45% hard seed. These tests were made in the fall as the seed was received.

Both the laboratory and field tests were made in triplicate and the results averaged. The laboratory tests were made between folds of moist blotting paper at a constant temperature of approximately 20°C and the counts made at the end of 6 days. The time of making the laboratory tests was soon after the field plantings were made. The field tests were made by planting the seeds in rows at a rather uniform depth of one inch and placing 100 seeds in each row. The rows were eight feet long and one foot apart. The soil was a clay loam which had been fallowed the previous year and was in good tilth and free from weeds. The dates of planting were from May 27 to June 6 and the counts of the plants were made at periods of three weeks, four weeks, and seven weeks after planting. The plants were removed as counted.

RESULTS

Change in Hard Seed Content in Storage.—The alfalfa, sweet clover, and red clover which were obtained from the Montana laboratory were compared as to hard seed content and germination in the fall and in the following

spring. The seeds were stored in paper envelopes at laboratory temperature. The results of this comparison are given in Table 2. The high hard seed alfalfa had a drop of 18% in hard seed and an increase of 21% in germination, while the low hard seed alfalfa had a drop of but 2% in hard seed and an increase of about 3% in germination. The sweet clover showed a slight increase in both hard seed content and germination. The red clover showed a 3% decrease in hard seeds and the same amount of increase in germination.

Hard Seed and Field Germination.—Using the mean values for hard seeds and for germination in the laboratory and in the field, some interesting relationships were observed. As shown in Figure 1, the high hard seed alfalfa with 28% hard seed, showed a laboratory germination of 67% and a germination in the field of 66% in three weeks, of 72% in four weeks, and 75% in seven weeks. The low hard seed alfalfa, with 13% hard seed, showed a laboratory germination of 75% and a field germination of 65% in three weeks, 68% in four weeks, and 70% in seven weeks. These two cases show rather strikingly how the hard seed in alfalfa came into the picture in the field germination. The difference in the spread between laboratory germination of 1% for the high hard seed lot and 10% for the low hard seed lot in three weeks seems significant and indicates something as to how the hard seeds responded to the soil conditions in that time. The subsequent germination in the one and three week periods following the initial three weeks is also significant in that it showed a continued germination of the hard seeds amounting to 9% in the high hard seed lot and 5% in the low hard seed lot. The data for these are given in Table 1.

In the same table with alfalfa, are shown comparable data for three lots of sweet clover. One lot was from Montana and had 37% hard seed, one was a composite of samples from Minnesota and Wisconsin and had 12% hard seed, while the third one was made up of samples from North Dakota and Iowa and had 22% hard seeds. With the mean values of these hard seeds ranging from 12 to 37%, the laboratory germination was from 56 to 60%, and the field germination in three weeks was from 38 to 45%. The behavior of the hard seeds in these sweet clovers in the field after the first three weeks is shown in the graph in Figure 1. The germination of the Montana lot had increased but 4% in the first week after the three-week period and another 4% in the three weeks following that, while the other two lots had increased 6 and 9%, respectively, in one week and but 0 and 1% in the next three weeks. This would seem to indicate that the high percentage of hard seeds in the Montana sweet clover was less responsive to the germinative conditions in the soil than were the smaller percentages in the other two lots of seed.

In Table 1 are shown the laboratory germination and hard seed content of three lots of red clover and one each of alsike clover and white clover, together with the field germination in three, four, and seven weeks for each. It is apparent that the hard seed had some part in the production of plants in the field after the first three weeks, but this part is not clear, since the numbers of such plants did not correspond to the percentages of hard seeds. At least, the relationship is not as striking as it is in alfalfa.

TABLE 1.—*Source of seed together with mean values for laboratory and field tests.*

Kind and source	Number samples in lot	Laboratory		Field plants in weeks		
		Germination	Hard seed	3	4	7
		%	%	%	%	%
Alfalfa:						
Montana[1]	148	67 ± .669	28 ± .604	66 ± .583	72 ± .553	75 ± .514
Montana[2]	147	75 ± .408	13 ± .457	65 ± .578	69 ± .570	71 ± .578
Sweet clover:						
Montana	170	56 ± .982	37 ± 1.004	41 ± .694	44 ± .741	46 ± .761
Minnesota and Wisconsin	102	60 ± 1.023	12 ± .902	39 ± .826	48 ± .703	48 ± .709
North Dakota and Iowa	166	60 ± .952	22 ± .896	45 ± .664	51 ± .693	52 ± .701
Red clover:						
Montana	77	73 ± 1.119	16 ± .882	60 ± .837	65 ± .922	66 ± .902
Minnesota	75	72 ± .813	10 ± .480	55 ± .879	60 ± .908	60 ± .896
Wisconsin	100	80 ± .397	10 ± .355	61 ± .488	67 ± .475	67 ± .528
Alsike clover: Montana, Minnesota and Wisconsin	66	72 ± .715	15 ± .581	41 ± .705	45 ± .705	46 ± .699
White clover: Montana and Minnesota	80	74 ± .697	18 ± .774	34 ± .685	40 ± .720	40 ± .739

[1]High hard seed content—45% hard seed in fall.
[2]Low hard seed content—10% hard seed in fall.

TABLE 2.—*Change in hard seed content and germination during storage in laboratory from fall to following spring.*

Kind of seed	Number of samples in lot	Fall		Spring	
		Germination	Hard seed	Germination	Hard seed
		%	%	%	%
Alfalfa—High hard seed content	148	46 ± .37	45 ± .39	67 ± .67	28 ± .90
Alfalfa—Low hard seed content	147	78 ± .36	10 ± .28	81 ± .51	9 ± .31
Sweet clover	170	51 ± 1.02	33 ± 1.04	56 ± .98	37 ± 1.01
Red clover	77	71 ± 1.27	21 ± 1.22	74 ± 1.12	19 ± 1.10

CORRELATION STUDIES OF LABORATORY AND FIELD GERMINATION

The term "correlation" means a relationship. A correlation coefficient between two variables is a measure of the degree which they tend to be associated or to move together. When this association or movement is in the same direction, keeping perfect step all the way, the coefficient is + 1.000; if, on the contrary, this movement should be in opposite directions, but at the same proportional rates, the coefficient would be − 1.000. If part

of the individuals in a population fail to move in the same direction as the others or at different rates, the coefficient becomes less and drops away from the perfect correlation of ± 1.000. It is for this reason that when working with biological material, such as the germination of seeds, perfect associations do not occur and hence we obtain coefficients lying somewhere between + .95 and − .95.

TABLE 3.—*Typical correlation table showing a rather high correlation coefficient of 0.723 between laboratory germination plus half the hard seeds and the field germination in seven weeks.*

Field germination, %	Laboratory germination plus half the hard seeds, %.										
	61–64	65–68	69–72	73–76	77–80	81–84	85–88	89–92	93–96	97–100	Totals
96–100								1		1	2
91–95									2	1	3
86–90							4	2	4	2	12
81–85		1*			2	8	3	4	2		20
76–80				4	5	19	3	1			32
71–75				11	12	10	3	2			38
66–70				5	7	3	3				18
61–65				3	3	1	1				8
56–60			5	3	3		1**				12
61–55	1		1	1							3
Totals	1	1	6	27	32	41	18	10	8	4	148

If all of the figures, representing samples of seed, had fallen on a diagonal line extending from the lower left hand corner to the upper right hand corner, the coefficient would have been 1.000. Note the position of the two samples of seed indicated by stars and see discussion in text.

As an example of a high positive correlation, let us examine Table 3. This is a typical correlation table made up by indicating each sample of seed in a special space according to the two pairs of results, the laboratory germination plus half the hard seed and the field germination. It will be observed that all of the samples, except two, arranged themselves fairly close to a line extending diagonally from the lower left hand corner to the upper right hand corner of the square. If all the samples had fallen exactly on this line, the result would have been a perfect correlation of + 1.000, but as it so happened the correlation was + 0.723.

The two samples in this Table 3 which are marked by * and ** are of special interest as they both tended to lower the correlation coefficient; the one on the left lowering it more because of the distance from the diagonal line and also the direction from the line. Since the positions of all the samples in this table were fixed on the perpendicular lines by the field germinations, let us notice how the positions of these two were changed on the horizontal lines by the addition of the hard seeds to the laboratory germination of each. The sample marked * had a laboratory germination of 44% with 43% hard seed, which made 66% for this table when half the hard seed was added. The field germination was 82%. This was an unusually high field germination for this laboratory test and showed that all, or nearly all,

of the hard seeds had germinated, thus throwing this particular sample out of step with the others. If all the hard seed had been added, this sample would have been exactly on the line. The other sample marked ** had a laboratory germination of 69% with 31% hard seed, or 85% when half the hard seed had been added. The field germination was 59%. This showed that plants were produced by only part of the seeds which were not hard and probably by a rather small proportion of the hard seeds. This sample was out of step because of the low field germination. If no hard seed had been added, this sample would have been very close to the line. A further analysis of this table would reveal many other cases in which samples of seeds behaved much the same as these did.

TABLE 4.—*Correlation between laboratory germination and field germination, both with and without hard seeds being added to the laboratory germination. Ten lots of leguminous seeds*

Kind and source of seed	Number of samples in lot	Correlation coefficients for laboratory and field tests[1] [2] [3]		
		Lab. germ. and no hard seeds	Lab. germ. plus ½ of hard seeds	Lab. germ. plus all of hard seeds
1. Alfalfa, high hard seed, Montana	148	.658	.723	.472
2. Alfalfa, low hard seed, Montana	147	.489	.430	.405
3. Sweet Clover, Montana	170	.696	.761	.244
4. Sweet Clover, Minnesota and Wisconsin	102	.879	.683	.587
5. Sweet Clover, North Dakota and Iowa	166	.809	.761	.400
6. Red Clover, Montana	77	.770	.733	.424
7. Red Clover, Minnesota	75	.756	.825	.804
8. Red Clover, Wisconsin	100	.374	.442	.421
9. Alsike Clover, Mont. Minn., and Wis	66	.462	.467	.210[4]
10. White Clover, Mont. and Minnesota	80	.472	.588	.246[4]

[1]Laboratory tests, 6 days; field tests, 7 weeks.

[2]See Table 1 for percentages of hard seed and other laboratory and field test results.

[3]Significant differences between coefficients are taken as being 0.100 or more for the purpose of comparisons.

[4]These coefficients are not large enough to be significant, considering the limited number of individuals in the test.

RESULTS OF CORRELATION STUDIES

In Table 4, are given certain correlation coefficients for ten lots of seeds. These figures show the relationship of laboratory tests to field tests from three standpoints; (1) laboratory germination only, (2) laboratory germination plus half the hard seeds, and (3) laboratory germination plus all of the hard seeds. Even though these coefficients range from 0.210 to 0.879, they are all positive and, with the exception of two, are of sufficient magnitude to be significant.

As has been shown in Table 3, each of these coefficients has been made up by the results of two tests on each of a large number of samples. When the laboratory germination alone was considered, a particular sample of

seed may have fallen, let us assume, a certain distance to the left of the imaginary diagonal line. If half of the hard seeds are added to the germination, the position of the sample may move back to the line and thus increase the coefficient; or if all the hard seeds are added, the position may be changed to the right of the line, and thereby decrease the coefficient for this particular sample to nearly its original magnitude. Other samples may fall in other positions and their coefficients be affected in various ways by the addition of half or all of the hard seeds. When this reasoning is applied to the lots of seeds in Table 4, it helps us to visualize how the correlation coefficients and hence the relation of laboratory germinations to field germinations are influenced by the addition of all or part of the hard seeds.

INFLUENCE OF HARD SEEDS ON CORRELATIONS

When half of the hard seeds were added to the laboratory germination, only two coefficients, as shown in Table 4, were changed significantly from those when germination alone was considered. These were sweet clover which was reduced 0.196 and white clover which was increased 0.116. The coefficients for the other eight lots of seeds were not changed as much as 0.100, thus indicating that half the hard seeds could be added to the laboratory germination for the purpose of interpretation of field germination in all cases except one of these ten lots of seeds. This one case was sweet clover which had 12% hard seeds.

When all of the hard seeds were added to the laboratory germination, seven of the coefficients were significantly reduced from those obtained when the germination alone was considered. These were one alfalfa, three sweet clovers, one red clover, and one each of alsike clover and white clover, and the amount of this reduction ranged from 0.186 to 0.452. The seeds, the coefficients of which were not reduced, were one alfalfa and two red clovers.

CONCLUSIONS AND SUMMARY

In summarizing this one year's results, it seems reasonable to draw the following conclusions as applying to these particular lots of seeds:

1. During storage from fall to the following spring, hard seeds were reduced 17% in one lot of alfalfa and 1% in another, none in sweet clover, and 2% in red clover.
2. A comparison of laboratory germination with field germination in seven weeks gave the following results: for alfalfa, 71 and 73%; for sweet clover, 59 and 52%; for red clover, 75 and 64%; for alsike clover, 72 and 46%; and for white clover, 74 and 40%.
3. The simple correlation can be used to advantage in studying the effect on the laboratory test as a means of interpreting the field value of seed when all or part of the hard seeds are added to the laboratory germination.
4. When all of the hard seeds were added to the laboratory germination and the sum correlated with the field germination, alfalfa and red clover were the only seeds in which the coefficients were not significantly reduced as compared with the coefficients for laboratory germination without the hard seeds.
5. When half of the hard seeds were added to the laboratory germination and the sum correlated with the field germination, the coefficients

compared well with those for germination without the hard seeds for two lots of alfalfa, two lots of sweet clover, three lots of red clover, and one lot each of alsike clover and white clover.

6. Half the hard seeds may safely be added to the laboratory germination of alfalfa, red clover, alsike clover, white clover, and to certain lots of sweet clover, for the purpose of interpretation of the field value of these seeds.
7. All the hard seeds should not be added to the laboratory germination, except in certain lots of alfalfa and red clover.

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COMMERCIAL SIGNIFICANCE OF HARD SEEDS IN PEAS[1]

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Hard seeds in certain legumes have been observed for centuries. The fleshy-seeded legumes, however, do not commonly contain noticeable percentages of hard seeds or hard-shell seeds. A few varieties of beans (Lazy Wife, Kentucky Wonder Pole, Green Refugee, Golden Wax, and occasionally Brittle Wax) have exhibited a hard-seeded condition for several years in our germination tests. Until the western crop of peas of 1936 was germinated, hard seeds have been encountered so infrequently as to be ignored entirely. During the past season, many samples contained unswollen seeds at the end of a standard six-day paper towel test. A variety of recent introduction, Wisconsin Early Sweet, seemed to be characteristically hard-seeded. A few samples of Surprise contained varying percentages, 1 to 20, of hard seeds in laboratory tests. Another new variety, Early Perfectah, was found to produce only 75% of normal sprouts in six days, while the entire remainder were unswollen. Several western seed growers have been seriously concerned about this condition, since they do not care to increase the crops of inherently hard-seeded varieties. Eastern canning-pea producers were also interested because a delay of a week in emergence of seedlings make an uneven maturing crop.

From the seed analyst's viewpoint it is important to know if hard seeds in the laboratory are an indication of the same condition in the soil. To answer this question, a few samples were planted in quadruplicate in greenhouse soil, varying from completely sterilized in the 1st series to highly contaminated in the 4th. Seedling counts as given in Table 1 were made in 10, 21, and 29 days following planting. Delay in soil emergence appears to be due partially to hard seeds but also to other factors. On the other hand, the seeds of Early Perfectah either germinated very promptly in soil or very possibly many more seedlings would have emerged if the experiment had been extended over a longer period. This contention is strengthened by the report from a prominent packing company that a planting of this variety made only 75% to 80% of the expected prompt field germination.

In the presence of moisture supplied by paper towels, the seed coats of the hard peas gradually became permeable to water. As shown in Table 2, many of the unswollen seeds in six days had sprouted in 12 days, but a few remained unswollen at the end of 18 days. The sample No. 10305 was divided into six parts and treated with various chemicals. In 13 days, the unswollen seeds were determined to be 1, 1, 3, 1, 1, and 2% as compared to 1% for the controls. All of the seeds were held until they had rotted or germinated. In 20 days, only 1 seed remained hard, and it started to swell on the 47th day.

Soaking the peas in water overnight made selection of the hard seeds possible. Additional soaking seemed not to accelerate the process of germi-

[1]Approved by the Director of the New York State Agricultural Experiment Station for publication as Journal Paper No. 222.

nation. If the unswollen seeds were clipped, germination followed promptly and to a slightly higher percentage than for those which germinated normally.

TABLE 1.—*Relation of hard seed content of peas to soil emergence in greenhouse.*

Variety	Laboratory germination in 6 days		Soil emergence			Increase in soil emergence
	Normal germination	Hard seed	10 days	21 days	29 days	
	%	%	%	%		%
Wis. Early Sweet	97	0	67	75	76	9
	96	1	51	62	62	11
	96	1	50	60	62	12
	96	2	63	74	75	12
	96	2	62	76	77	15
	94	2	53	63	64	11
	88	2	54	62	62	8
	88	2	54	63	64	10
	95	2	72	82	83	11
	92	3	60	66	67	7
	94	3	64	83	84	20
	94	3	68	79	79	11
	86	4	33	41	42	9
	93	5	67	76	77	10
	94	5	75	80	81	6
	92	6	70	78	79	9
	81	10	51	57	58	7
	70	15	40	53	55	15
Surprise	87	1	47	54	57	10
	91	4	59	68	70	11
	92	6	60	70	72	12
	88	8	64	75	77	13
	90	8	86	90	91	5
	86	10	64	73	75	11
Perfectah	75	25	56	60	63	7

TABLE 2.—*Duration of hard seeds in peas in laboratory germination tests.*

Lab. No.	Germination and hard seeds					
	6 days		12 days		18 days	
	Germination	Hard seed	Germination	Hard seed	Germination	Hard seed
	%	%	%	%	%	%
9908	94	5	4	0	–	–
10265	92	6	4	2	1	1
9907	86	10	7	2	1	1
9936	85	10	8	2	0	2
10267	88	10	8	2	2	0
9519	82	15	9	6	5	1
9818	73	17	12	5	3	2
9998	78	18	14	4	3	1
10734	75	25	14	11	4	7

TESTING SEED OF *PASPALUM DILATATUM*

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Division of Seed Investigations, U. S. Department of Agriculture, Washington, D. C.

The testing of seed of *Paspalum dilatatum* has involved many difficult problems. The heavy lemma and palea make it difficult to definitely determine the presence or absence of a caryopsis without danger of injury to the embryo. Ergotized seeds, which are common in this species, are not as definitely detected as in most other grasses. These difficulties are believed to have been the cause of much variation in germination results.

The difficulty of making a separation of this seed and of obtaining a representative sample for germination, led the Division of Seed Investigations during the past year to try out a new procedure of testing this seed, which is an adaptation of the direct method.

The general plan is to make a separation on a large sample and calculate a percentage of all heavy material that looks like seeds. From this separation, a weighed amount is tested for germination. Since neither of the percentages determined correspond to the usual purity or germination percentages, the results are reported only as "live pure seed".

The detailed procedure is as follows: After mixing and dividing, a five-gram sample is weighed. This is blown to remove the light chaff. The percentage of heavy material, including "empty glumes", ergotized seeds, and foreign material, is calculated. From the heavy material, two one-half-gram samples are weighed and from these all foreign seeds, sticks, and dirt are removed. The samples are reweighed, and a corrected percentage of "heavy seeds" (including "empty glumes" and ergotized seeds) is calculated. These two samples are tested for germination in petri dishes at a room, 35°C alternation. At the end of 21 days, the remaining "seeds" are counted to determine the total number tested. Because the "empty glumes" do not vary greatly in weight from the "filled seeds", a germination percentage may be calculated from the number of seedlings and the total number of "heavy seeds" tested.

It is believed that the live pure seed value by this method is more dependable than by the usual method. In comparative tests, the results obtained have been similar to those from the customary method and require much less time. In testing for germination, some samples have been benefited by moistening the substratum with KNO_3. Freshly harvested seed may require a longer period than 21 days for the germination test.

ASSOCIATION MEMBERS AND GUESTS ATTENDING THE 29TH ANNUAL MEETING AT WASHINGTON, D. C., AUG. 25, 1937.

Front row—(left to right J. E. Benedict, Jr., Dorcas Hooker, Lucy W. Morton, Ada G. McFarland, Jennie S. Jones, Kercheval E. Smith, George A. Elliott, Harry E. Vegiard, Marvin H. Snyder, E. O. Brown, V. L. Pemble, ————.

Second row—C. M. Bass, Ruth E. Evans, Jessie Anderson, Lawrence T. Berry, E. H. Toole, Vivian Kearns Toole, Thelma Hendrixson, Miss Brown (reporter), W. A. Davidson, Helen B. Peebles, Mary Akers, Alice M. Andersen.

Third row—C. W. Leggatt, A. C. Heise, Andrew Hope, C. A. Stahl, C. P. Steinbauer, W. O. Whitcomb, L. N. Allen, C. N. McIntyre, Macy L. Spracher, Harriet Cull, A. L. Stone, Albina F. Musil.

Fourth row—Emma F. Sirrine, Anna M. Lute, Edith C. Higgins, Ruby U. Crouley, Helen Horn, Marian Kellogg, Grace H. Blakeborough, R. H. Haskell, S. F. Patrick, Alma Eggleston, Clara Mangelsdorf, W. W. Oppel.

Fifth row—J. A. Pepin, Louis A. Ames, Mary C. Mowry, Regina B. Schulte, Dolores Weimer, Clara Fuhr, ————, W. J. Lackey, Mrs. J. W. Zahnley, J. W. Zahnley, ————, M. T. Munn.

Sixth row—Cecil Tapp, G. A. Scott, Alma Everard, F. A. McLaughlin, Royden L. Hammond, Elizabeth M. Eby, J. E. Casey, Mildred B. Henry, Raymond Kinch, ————, J. W. Woodside, R. H. Porter.

Seventh row— ———, ———, ———, ———, Verne Snell, Bertha DeHam, Louise C. Baker, Susie D. Allen, Bessie G. Sanborn, ———, ———, ———.

Note: Vacant seats ———.

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